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GRAIN SUBTERMINAL STUDY

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AUGUST 1981

250 copies of this public document were published at an estimated cost of $2.54 per copy for a total cost of $635.00 which includes $535.00 for printing and $100.00 for distribution.

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Fellow Montanans:

The following report on Grain Subterminal Feasibility for the State of Montana has been prepared by Roger Creighton Associates, Inc. (RCAI). RCAI is a consulting firm with considerable past experience in railroad planning, costing, and feasibility studies.

In this study effort, RCAI was charged with evaluating the economic and institutional feasibility of applying a grain subterminal and unit train grain transportation concept to Montana's complex transportation structure.

The findings, conclusions, and recommendations of this report do not reflect state government policy or position on grain subterminal development in the state. They are simply the independent, professional assessments of one consulting firm. These findings will, however, provide valuable background as we press forward in formulating state economic and transportation policy.

We would appreciate hearing from you as to any comments or suggestions you may have. Please feel free to call us at 449-3494 or 449-3423.

Gary Buchanan, Director
Montana Department of Commerce

William J Fogarty

William J. Fogarty, Admn.
Division of Transportation

WJF/jl

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FINAL REPORT

BULK FREIGHT GRAIN TRANSPORTATION SYSTEM STUDY

Prepared for the

Montana Department of Highways
2701 Prospect Avenue
Helena, MT 59620

the

Montana Department of Agriculture
Agriculture/Livestock Building
Capitol Station
Helena, MT 59620

and the

Montana Department of Commerce
1424 9th Avenue
Helena, MT 59620

by

Roger CREIGHTON ASSOCIATES Incorporated
274 Delaware Avenue
Delmar, NY 12054

Robert Peccia & Associates
810 Hialeah Court
Helena, MT 59601

Radermacher & Associates
Suite 301 - MTN Building
3203 3rd Avenue North
Billings, MT 59101

August 19, 1981

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SUMMARY REPORT

Background of the Study

The "Bulk Freight Grain Transportation System Study", or Grain Subterminal Study, is an outgrowth of the initial Montana Rail Plan, which found that major investment in rehabilitating 1920's era light density rail lines by itself would do little to solve the car supply, service, and rate problems affecting the use of the rail system for the transport of wheat and barley. It was reasoned that a better solution would be to modernize the entire grain collection and marketing system to lower transport and handling costs (which are ultimately paid for by the grower) thus placing Montana in a stronger competitive position vis-a-vis the other principal wheat-producing states.

Montana's principal markets for wheat and barley have traditionally been the west coast and the upper midwest. In recent years, a majority of the wheat has moved west through the Seattle, WA or Portland, OR gateways to export markets.1/ On the other hand, virtually all of the barley is shipped to domestic markets, primarily maltsters or feed lots. Over the years, the proportion of the grain traffic handled by the railroads and motor carriers has varied, depending to a large extent upon the rail rates relative to truck rates and also on the backhaul possibilities for trucks. The proportion of wheat hauled by rail consequently has varied between roughly 60 and 90 percent of total grain movements. During the 1970's, modal shares were affected by such changes as: (1) the lowering of single car rail rates in

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1/ In the last year, further specialization has occurred whereby virtually all wheat now moves through Portland or other nearby Columbia River ports, whereas Seattle has focused on feed grains.

August 1976 and more recently in December, 1980, (2) waterways improvements to the Snake and Clearwater Rivers and the construction of river terminals at Lewiston, ID permitting grain transport by barge starting in February 1975, and (3) variability in the availability of rail cars and in the reliability of rail service (transit times). During this period, the railroads have sought to maximize their profits on hauling Montana grain, an objective different from seeking to dominate in the physical handling of grain. Railroads do, however, monitor the effects of truck competition; when the rail share of the market has dropped to roughly 50-60 percent, the BN has in the past countered by reducing single car rates to recapture a portion of the traffic being lost to motor carriers. Usually this reduction has meant eliminating some of the privileges or enroute services heretofore performed or by adding assessorial charges to recapture the costs of ancillary services.

Although volume rates for agricultural products have been in existence for some time in states enjoying strong intramodal competition, until recently the BN has not expressed much interest in implementing such rates in Montana.[1/] Thus, BN's decision to introduce volume rates on 26 and 52 car units effective December 1, 1980 (and at the same time reduce single car rates) reflected a major change in corporate policy and came about more quickly than State officials had anticipated. BN's intent in offering multi-car rates (26-cars from one or two to four origins) was to provide a transition between single car and unit train service, the latter being limited to 52 cars for

---

1/ For example, volume rates have been offered by the BN and the UP on export corn and wheat originating in Nebraska and moving west for some time. Typically, the UP has been the leader in offering volume rates with the BN being forced to reciprocate in order to maintain its market share.

braking reasons over the Rockies.[1] The BN recognized that Montana country elevators simply did not then have the capability of loading out unit trains, and that interim multi-car rates were necessary in order to provide the incentives needed to construct subterminals or to expand the load-out capabilities of existing elevators. Thus, BN introduction of volume rates represented a pricing strategy which over time was expected to (1) force greater centralization of grain collection and marketing, (2) reduce truck competition, and (3) increase the profitability of grain traffic through the greater cost efficiencies of unit trains (versus single car service). In short, it forces changes which, if they had been advocated solely by State government, would not have been implemented for a long time.

Anticipated Impacts

Present indications are that volume rates will indeed unleash a wave of capital investments to expand the capabilities of the larger existing grain public warehouses by extending side tracks and improving loadout capabilities to take advantage of the 26-car rate offered by the BN. With several exceptions, these rates have not yet resulted in private enterprise decisions to construct subterminals _per se_, although this may be the consequence of high interest rates rather than explicit decisions against implementing subterminals. Ultimately, full unit train rates are expected to provide the financial incentives for one or more of major grain companies to invest in strategically-located subterminals.[2]

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[1] Originally, the 26-car rate from two to five origins was set to expire at the end of 1981, although the BN has since extended the rate for an additional year.

[2] Since the major grain companies ultimately handle the grain produced in Montana, they would tend to enter the collection and marketing end of the business only if the overall profitability of subterminals by themselves was great enough and by so doing they could achieve an advantage over competitors. Grain companies generally seek to avoid destructive head-to-head competition, however.

Implementation of such facilities would force others (independents or cooperatives) to consider similar facilities simply to survive, provided that they can secure the necessary funding.[1] Initial improvements to existing public warehouses will intensify price competition among country elevators, which will result in increased attrition of the smaller elevators (or those not capable of being expanded to take advantage of the 26-car rate). The grower may, over the short-run, benefit from such competition in the form of a higher price for his product. Ultimately, subterminals capable of efficiently handling 52-car trains will supersede many of the lesser facilities, resulting in further concentration of grain collection and marketing activities and an erosion of marketing alternatives for the grower.

While it appears that a substantial number of existing elevators in the Golden Triangle and Northeastern Montana will be converted to handle 26 cars, these facilities will not be true grain subterminals.[2] The chief motivation in expanding existing facilities is one of remaining in the grain marketing business, or at least retaining one's traditional market share. Overbuilding is inevitable as firms seek to dominate their competitors. Many of those grain public warehouses incapable of being expanded would eventually be forced out of business. Outside of the Golden Triangle and the Northeast, grain public warehouses would continue, but at a growing disadvantage as the spread between single car and volume rates widens.

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[1] Cooperatives generally do not have the same assets and credit rating that the major grain companies have. State officials have received indications that local banks are rather hesitant in lending money for track and elevator improvements to take advantage of the 26-car rate.

[2] The tendency will be to adapt existing facilities to meet momentary railroad-imposed tariff conditions rather than to start from scratch and develop the automatic weighing, conveying, storage, inspection, blending, and loadout capabilities required for true subterminal capability. Unless the latter is done, there will be no change in functions performed (i.e., no shifting of present terminal elevator functions back to the hinterlands). Existing facilities would simply become expanded "pumphouses".

Overview of the Study

The grain subterminal study focused on determining the economic feasibility of the grain subterminal concept as applied to Montana. Feasibility depends upon whether proposed subterminals generate sufficient economic benefits for grain growers and elevator operators to overcome the inherent fear and distrust of a major change in the collection and marketing of grain. If proven feasible, future steps would then include determining the organizational and institutional mechanisms for implementing grain subterminals.

The term "feasibility" means different things to the parties involved. Feasibility to grain growers means a higher price for export wheat, which is achievable only through a reduction in transport charges, since the major grain markets essentially determine delivered price. Feasibility to public warehouses means lower overall transport charges. In other words, the reduction in rail rates (unit train versus single car) must more than offset the annualized cost of converting an existing elevator to be capable of handling multiple carloads, or the costs associated with marketing through a subterminal, which includes (1) transporting grain by motor carrier from the public warehouse to the subterminal and (2) associated handling and storage charges at the subterminal. Feasibility to railroads means greater profitability over that presently enjoyed. This means that the reduction in carload revenues must be more than offset by the sum of: (1) increased traffic, (2) operating cost savings stemming from the use of unit trains in lieu of conventional service, (3) cutbacks in the frequency of local way freights presently serving public warehouses, thus further reducing operating costs, (4) greater equipment utilization, thus reducing the size and cost of the car fleet needed to move Montana grain, and (5) reductions in infrastructure costs through abandonment of branchlines no longer needed with the implementation of subterminals.

Given the above objective, the study focused on three main alternatives which were (1) continuing the single car service that existed prior to December 1, 1980, (2) adding subterminals, but keeping public warehouses as local collection and marketing points, and (3) adding subterminals by phasing out present public warehouses. Subterminals would concentrate on export wheat; remaining public warehouses would continue to handle barley and wheat not moving west.1/ With the introduction of volume rates, the first alternative is not a viable course of action, but merely serves as a reference point against which to quantify potential changes brought about by subterminals.2/ Although not examined in great detail, a fourth alternative involving improvements to 40-50 existing grain public warehouses to be able to handle 26 car units is also possible. This, in effect, is a half-way solution which appears to be popular primarily because it causes less severe change to the grain collection system.

1/ The study has assumed that subterminals will specialize in volume shipments of wheat moving west and not take on carload shipments of barley and wheat (e.g., duram destined to other markets, although this could be readily handled by subterminals. Redundant public warehouses may choose to change functions, such as becoming feed and seed outlets. Still others will probably be sold to growers for use as private storage, a trend which is already happening. If several cooperatives join together in building a subterminal, present public warehouses could conceivably become storage adjuncts to the subterminal. The above changes will probably occur gradually over a five to ten-year period.

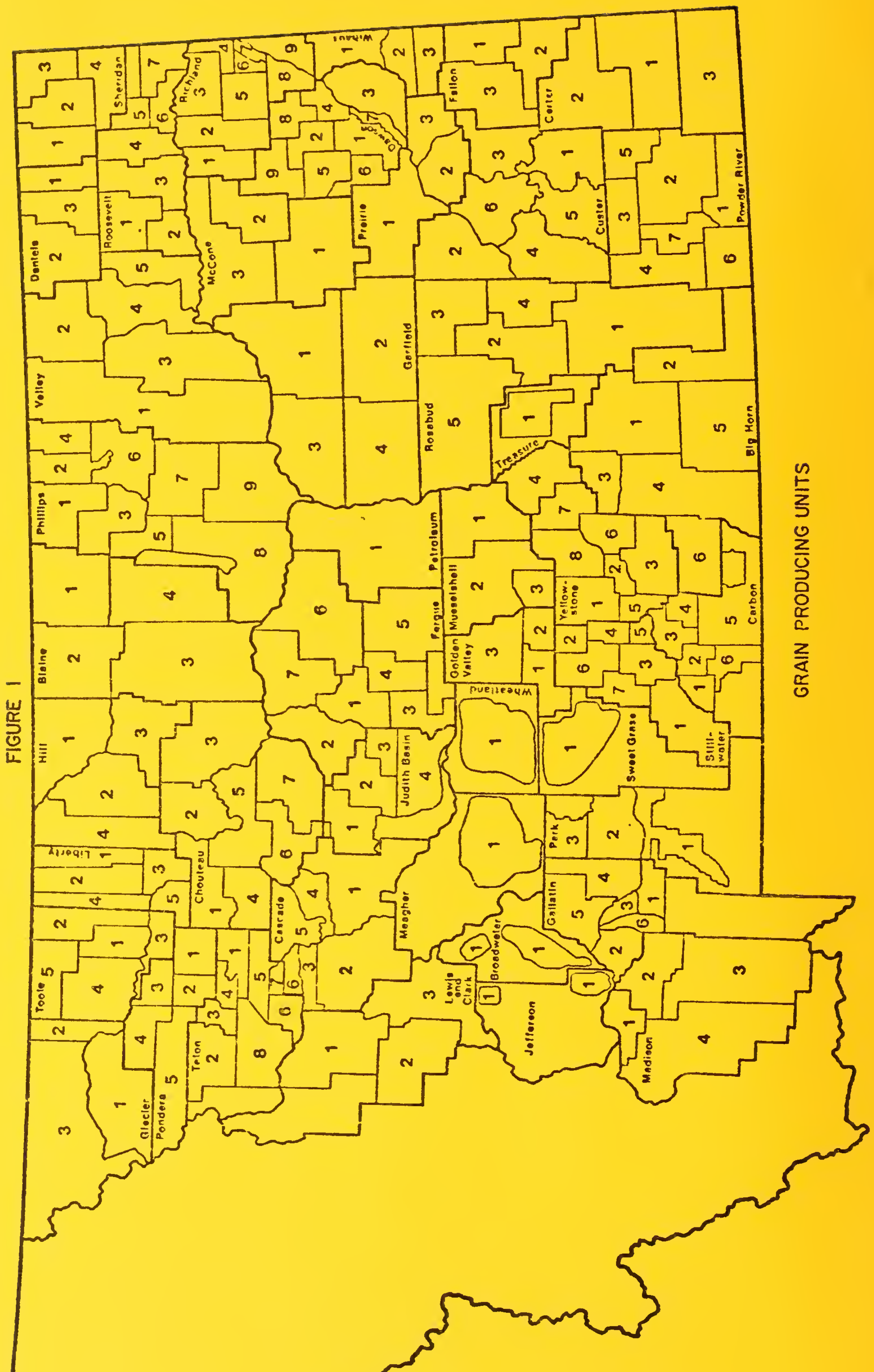
2/ 1979 grain transport data were used to represent the base year, adjusted to reflect December 1980 transport rates and costs. These data reflect the modal shares which existed prior to the introduction of volume rates.

Study Methodology

The quantitative procedures used in this study were simple and straightforward. They made use of the rather detailed information available on producing unit production, public warehouse throughputs, and domestic and export markets for wheat.[1/] The methodology was based on the principle that the grower will choose the least cost transport so as to maximize the income received. For each commodity movement or "flow", the procedure involved systematically comparing costs and revenues associated with two (or more) routings between points of commonality (i.e., the producers at the origin end and the markets or market gateways at the destination end). The first routing, the null situation or base case, consisted of small volume flows moving from producing units to public warehouses to markets by up to five mode/destination combinations involving either truck or single car rail transport. The second routing, the proposed subterminal alternative(s), consisted of truck movements to subterminals (either direct from producing units or via public warehouses) followed by volume shipments from subterminals to markets using unit trains. The second routing never totally displaces the first, since there will always be some residual traffic which will continue to move by truck and single car rail. At each stage, information on the cost of providing the transport service and revenues derived therefrom by the transport company (charges or rates to the purchasers of the transport service) was developed and accumulated.

1/ Grain production information was supplied by the Montana Office of the USDA Agriculture Stabilization & Conservation Service. Elevator throughputs were obtained from grain transport data maintained by the Montana Department of Agriculture. Carloading information was supplied by the BN and the Milwaukee. Mode/mode combinations included rail and truck to Pacific Northcoast ports and interior Oregon/Washington stations and truck/barge through Lewiston, ID and other Snake/Columbia River ports.

FIGURE 1



GRAIN PRODUCING UNITS

Much of the technical effort was spent in objectively determining costs, charges and revenues to affected parties for transporting and handling grain.[1] Participants include the grain growers, elevator operators (public warehouses and subterminals), and transporters (railroads, motor carriers, barge lines, and farm trucks).[2] Single car and unit train rail service were treated as two different services as were motor carrier line haul and collector services. Motor carrier line haul transport refers to public warehouse to market or river terminal grain movements and includes an allowance for backhaul movements of other commodities. Collector services consist of a combination of public warehouse to subterminal and grain-producing unit to subterminal movements (the latter is limited to one-way trip lengths over 35 miles, which represents the economic "breakpoint" between farm and grain truck costs) and assume on an empty backhaul.

1/ Costs refer to manpower, fuel, and other expenditures incurred in providing transport or handling services. Revenues are the income received by transporters and elevator operators in return for services. Profits represent the difference between revenues and costs. Revenues are identical to charges, which are levied against the purchaser of the transport or handling service. In a few cases (e.g., farm trucks, barge operations, motor carriers providing collector services), transport revenues have been set equal to costs.

2/ The costs incurred and revenues earned for river terminals (motor carrier and barge interface) has been included in the costs and revenues developed for barge operations.

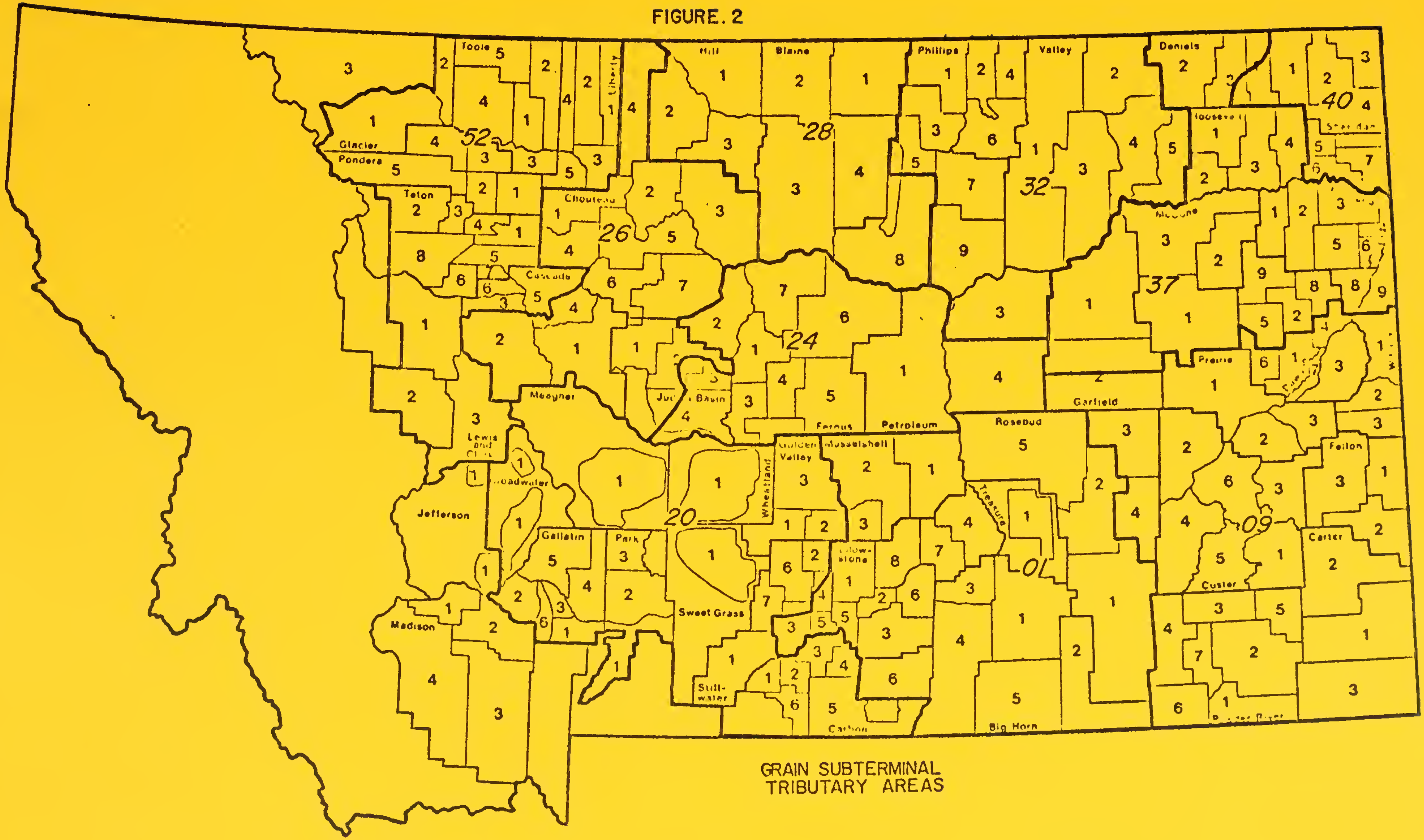
The procedure utilized was not intended to be a model for determining the optimum location for subterminals. However, as part of the accounting process to determine economic feasibility, it became necessary to conceptualize on the possible number and approximate location of subterminals needed to serve Montana growers. In hypothesizing locations, factors considered included (1) coverage of the state, (2) minimizing the distance between grain-producing units and the nearest subterminal, (3) rail rate structures --especially points where sizable differentials occur, and (4) minimizing the total number of subterminals to keep handling and storage charges as low as possible. Recognizing that a good location from a regional perspective could be moot if a satisfactory site was not available, a brief inspection was made of some 56 different sites to ensure the availability of at least one good site for a subterminal within its tributary area. Site factors considered included size and terrain, ownership, rail service, highway access, and the availability of utilities. In the end, ten locations were selected as part of the process for determining the feasibility of subterminals in Montana. Once selected, each grain-producing unit was then assigned to a subterminal based on highway routes/distances and long-standing patterns of local/regional commerce (see Figure 2).

Some further hypothesizing of the characteristics and operations of subterminals was also required. Recognizing the vast amount of on-farm storage existing in Montana and recent trends for using former public warehouses as private storage, the storage capacity of proposed subterminals was set at 500,000 bushels.1/ Subterminal land acquisition,

---

1/ This was increased to one million bushels for four high-throughput subterminals in Alternative 3 (where existing public warehouses are phased out). It was felt that additional storage was necessary to ensure adequate supplies of grain to meet contractual commitments during extended periods of adverse weather.

FIGURE. 2



GRAIN SUBTERMINAL TRIBUTARY AREAS

site preparation, trackage and construction costs were estimated to be $3.3 and $4.2 million for 500 thousand and one million bushel facilities, respectively.[1] Subterminals would have the capability of unloading all types of vehicles; however, under Alternative 2 (subterminals supplement public warehouses), delivery would continue to be by farm truck to public warehouses and under Alternative 3 (subterminals replace public warehouses), farm trucks would deliver directly to subterminals if the grain-producing unit was located 35 miles (one-way) or less from the subterminal. Subterminals would arrange for contract trucking to move the grain from public warehouses to the subterminal (Alternative 2) and from grain producing units located more than 35 miles from the subterminal (Alternative 3).[2] The handling/storage charge scenario initially contemplated was a 10.5 cents per bushel handling charge and 0.1 cents per bushel per day storage charge. This scenario resulted in the higher volume facilities subsidizing the lower volume facilities. Consequently, an additional scenario consisting of a variable handling charge and the 0.1 cents per bushel per day storage charge was tested under the proviso that each subterminal had to earn a ten percent profit.

In 1979, public warehouses handled approximately 109.9 million bushels of westbound wheat of which 88.7 million bushels was considered potentially capturable by subterminals and unit trains. These figures

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1/ Cost estimates utilize information supplied in part by Jacobson and Sons Construction Co., Inc. Bismarck, ND.

2/ Obviously, there is no present requirement that subterminals offer such a service. However, a collection service makes a lot of sense in neutralizing the economic disadvantages of growers not located in general proximity to subterminals as well as utilizing a mode which is more cost efficient than farm trucks (at longer distances). Acceptance of subterminals will be significantly improved if the costs of local transport can be equitably spread across all growers. An allowance or discount system based on distance from the subterminal represents another possibility.

for grain flows represent wheat moving through public warehouses, with no allowance being made to account for track buying or other movements for which information was not available. They were intended to be deliberately conservative.

Considerable variation existed in the grain potential of each of the ten subterminal tributary areas, with three subterminals handling more than 10 million bushels and one more than 20 million bushels annually.1/ Consequently, it was concluded that four of the subterminal tributary areas could probably support multiple subterminals, provided that competing subterminals were not at the same location. It was found that the additional operating and infrastructure costs from maintaining competing facilities was largely offset by reduced grain assembly (transport) costs.

Study Results

The overall results of the grain subterminal study substantiate what Montana officials had privately suspected for some time -- that subterminals were feasible as a replacement for, but not as a supplement to, existing public warehouses. The results also indicate that grain subterminals produce far greater benefits than lesser investment in expanding the capabilities of existing elevators to handle 26-car units.

The overall costs and revenues of a subterminal plan by themselves are of little consequence; what is important is the relative and absolute

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1/ After allowance for a limited amount of continued single car rail traffic and continued trucking to the west coast for spot movements and backhauls.

change from present conditions. This requires the use of a base case. The introduction of volume rates and reduction in single car rates adds a major complication, as comparisons made with conditions which no longer exist are not very meaningful. Three possibilities exist: (1) using the 1979 grain flow data and the then existing rate structures, (2) updating the preceding to reflect the new rail rates (and costs), and (3) using the preceding, but modifying the results to reflect the diversion from truck to rail occurring solely as a consequence of the lower single car rates. The first represents a bygone situation. The second reflects the situation as of December 1, 1980. The third is obviously the most satisfactory base, provided that the diversion from truck to rail can be measured or approximated. However, given the timing of this study, grain transport data indicating the diversion taking place as a consequence of the rate reductions simply were not available. Thus, two bases (costs and revenues both before and after diversion) have been included, with the former being based on detailed grain movement data and the latter an estimate based on the rail share increasing from the 68 percent occurring in 1979 to 85 percent solely due to the single car rate reduction. The figures shown for the two bases can be treated as a range, although the anticipated results should be closer to those indicated by the "after diversion" base case.

Table 1 presents transport system revenues and costs for Alternatives 2 and 2A summarized on a statewide basis. Under these alternatives, subterminals would supplement existing grain public warehouses. (The "A" alternative reflects variable rather than fixed handling charges.) The table shows that resulting charges to growers would be greater than those occurring under single car service. The collective cost to carriers and elevator operators would be slightly greater. Hence the finding that adding subterminals to public warehouses makes little economic sense.

TABLE 1

TRANSPORT SYSTEM REVENUES AND COSTS
(ALTERNATIVES 2 and 2A)

	Timing	Base	Alt. 2	Diff.	Alt. 2A	Diff.
Revenues/ Charges	before after	$133.4 128.6	$139.2	$ + 5.9 +10.7	$138.5	$ + 5.1 + 9.9
Cost to Carriers	before after	119.1 111.9	115.3	- 3.8 + 3.4	115.3	- 3.8 + 3.4
Profit to Carriers	before after	14.3 16.7	24.1	+ 9.8 + 7.4	23.2	+ 8.9 + 6.5

All figures are in millions.
Includes subterminal and residual (truck and single car rail) traffic.

Table 2 presents transport system revenues and costs for Alternatives 3 and 3A again summarized on a statewide basis. Under these alternatives, subterminals replace grain public warehouses. In this case the resulting charges to growers drop by roughly $7 to $12 million. Profitability to the carriers increases by 30 to 60 percent. Hence the finding that subterminals are economically feasible on a statewide basis and can lead to lower transport charges and rates.[1/]

[1/] Irrespective of whether single car rates before or after December 1, 1980 are used as the basis for comparison. However, it must be recognized that, in making the rate reduction, the BN is not being altruistic, but rather seeking to eliminate motor carrier competition and that once competition has been appreciably reduced, single car rates could eventually be increased back to roughly previous levels (excluding general rate increases to counter the effects of inflation).

TABLE 2

TRANSPORT SYSTEM REVENUES AND COSTS
(ALTERNATIVES 3 and 3A)

	Timing	Base	Alt. 3	Diff.	Alt. 3A	Diff.
Revenues/Charges	before after	$133.4 128.6	$121.7	$ -11.7 - 6.9	$ 120.8	$ -12.6 - 7.8
Cost to Carriers	before after	119.1 111.9	98.9	-20.2 -13.0	98.9	-20.2 -13.0
Profit to Carriers	before after	14.3 16.7	22.8	+ 8.5 + 6.1	21.9	+ 7.6 + 5.2

All figures are in millions.
Includes subterminal and residual (truck and single car rail) traffic.

Table 3 presents approximate transport system revenues and costs for a system of 40 to 50 quasi-subterminals, or existing grain public warehouses expanded to be able to handle 26-car units. The table indicates that the resulting charges to growers will be roughly equal to those occurring at the present time under single car service, even though the collective cost to carriers and elevator operators would go down somewhat. In this case, amortization of the capital cost to public warehouses incurred in adding track and making other improvements

TABLE 3

TRANSPORT SYSTEM REVENUES AND COSTS
(Larger Elevators Expanded to Handle 26-Car Units)

	Timing	Base	Quasi-Sub.	Diff.	Full Sub	Diff.
Revenues/Charges	before after	$133.4 128.6	$129.2	$ - 4.2 + 0.6	$121.7	$ -7.5
Cost to Carriers	before after	119.1 111.9	105.7	-13.4 - 6.2	98.9	-6.8
Profit to Carriers	before after	14.3 16.7	23.5	+ 9.2 + 6.8	22.8	-0.7

All figures are in millions.
Figures shown for the full subterminal based on Alternative 3.

to achieve rapid loadout capability offsets the 12 cents/bushel savings in the unit rail rate. The cost reduction stems from the unit cost savings made possible to the railroads from the 26-car multiple car rate, as compared with single car service. Also shown are the comparable results for a full subterminal (Alternative 3). The computations indicate that only full subterminals produce savings in transport charges which at least potentially can be passed back to the grower. Subterminals also produce further cost reductions for the carriers. The computations also indicate that the 26-car service is somewhat more profitable than unit train service; while this result may seem unusual, it is probably a consequence of the generalized costing procedure utilized. It is understandable by remembering that the BN is not likely to offer a volume rate unless it will result in a handsome profit to that railroad.

Tables 4 and 5 provide information on unit revenues and costs at the subterminal level. As would be expected, the reduction in unit revenues or charges and costs for subterminal tributary areas (as a whole) range considerably by location, with the greatest benefits occurring at subterminals having the highest throughput.

TABLE 4

SUBTERMINAL REVENUES AND COSTS (ALTERNATIVE 3)

Sub-terminal Location	Thru-put (m.bu.)	Unit Revenues/Charges ($/bu.)			Unit Costs ($/bu.)			Change in Profit-ability
		Base	Alt.3	Diff.	Base	Alt.3	Diff.	
01	5.59	1.29	1.25	- 0.04	1.18	0.99	- 0.19	+ 0.15
09	4.40	1.51	1.37	- 0.14	1.26	1.09	- 0.17	+ 0.02
20	3.23	1.16	1.09	- 0.07	1.08	0.98	- 0.10	+ 0.02
24	4.96	1.18	1.05	- 0.13	1.13	0.94	- 0.19	+ 0.06
26	16.59	1.09	0.97	- 0.12	1.07	0.84	- 0.23	+ 0.10
28	17.05	1.13	1.03	- 0.10	0.99	0.82	- 0.17	+ 0.07
32	6.26	1.33	1.20	- 0.13	1.14	0.96	- 0.18	+ 0.05
37	16.16	1.41	1.27	- 0.14	1.19	0.97	- 0.22	+ 0.08
40	8.85	1.39	1.29	- 0.10	1.17	1.00	- 0.17	+ 0.06
52	25.57	1.09	0.98	- 0.11	0.98	0.78	- 0.20	+ 0.06
Total/ Avg.	109.90	1.21	1.11	- 0.11	1.08	0.90	- 0.19	+ 0.08

TABLE 5

SUBTERMINAL REVENUES AND COSTS
(ALTERNATIVE 3A)

Sub-terminal Location	Thru-put (m.bu.)	Unit Revenues/Charges ($/bu.) Base	Unit Revenues/Charges ($/bu.) Alt.3A	Unit Revenues/Charges ($/bu.) Diff.	Unit Costs ($/bu.) Base	Unit Costs ($/bu.) Alt.3A	Unit Costs ($/bu.) Diff.	Change i Profit-ability
01	5.59	1.29	1.27	- .02	1.18	0.99	- .19	+ .18
09	4.40	1.51	1.41	- .10	1.26	1.09	- .17	+ .07
20	3.23	1.16	1.16	-	1.08	0.98	- .10	+ .09
24	4.96	1.18	1.08	- .10	1.13	0.94	- .19	+ .09
26	16.59	1.09	0.95	- .14	1.07	0.85	- .22	+ .08
28	17.05	1.13	1.01	- .12	0.99	0.82	- .17	+ .05
32	6.26	1.33	1.22	- .11	1.14	0.96	- .18	+ .06
37	16.16	1.41	1.25	- .16	1.19	0.97	- .22	+ .06
40	8.85	1.39	1.30	- .09	1.17	1.00	- .17	+ .07
52	25.57	1.09	0.95	- .14	0.98	0.78	- .20	+ .06
Total/ Avg.	109.90	1.21	1.10	- .11	1.08	0.90	- .19	+ .07

In addition, considerable variation exists within each subterminal tributary area. A further test was made to determine whether some savings was possible for most, if not all grain-producing units tributary to a subterminal. It was reasoned that a grower would utilize a grain subterminal only if the transport charges were less (or the price received for grain was higher by the same amount) than that which would occur from continued utilization of a public warehouse. Nine of the ten subterminal tributary areas produced potential savings for virtually all grain-producing units. Subterminal location #20 (in southwestern Montana) failed this test rather substantially, especially under the scenario requiring the facility to be self-supporting. Not only did this subterminal have the least volume of the ten, but the presence of the Interstate system and the relative proximity to Lewiston, ID provide a greater range of transportation alternatives than are available elsewhere. Consequently, the further finding that nine of the ten subterminals, four of which could be further subdivided, appear to be feasible either as part of a system of subterminals or on a stand alone basis.

Table 6 shows the potential benefits of subterminals to growers, provided that the savings are passed back. While the overall 14.2 or 15.3 cents per bushel savings for the subterminal user may not seem that large, this savings is in addition to the 14 cents per bushel already provided through the reduction in single car rates on December 1, 1980. Also shown is the overall unit savings of 10.6 or 11.5 cents per bushel which includes both subterminal and residual (truck and single-car rail) traffic.

TABLE 6

POTENTIAL BENEFITS TO GRAIN GROWERS
(ALTERNATIVES 3 and 3A)

	ALT. 3		ALT. 3A	
	Unit Charge	Savings	Unit Charge	Savings
Present	$ 1.214/bu.	-	$ 1.214/bu.	-
Subterminal User	1.072/bu.	14.2¢/bu.	1.061/bu.	15.3¢/bu.
Average User*	1.108/bu.	10.6¢/bu.	1.099/bu.	11.5¢/bu.

* Includes both subterminal and residual (truck and single-car rail) traffic.

Table 7 summarizes the overall impact upon railroads, which in this case is the BN. Two trends are apparent -- the diversion of truck to rail and the costs savings from substituting unit trains for single-car rail service. In short, BN stands to substantially increase the profitability of its grain transport operations in Montana.[1/] Obviously, the volume rates introduced on December 1, 1980 are designed for that purpose.

TABLE 7

IMPACT UPON RAILROADS

	Revenues	Costs	Profit	Return
Present	$ 74.4	$ 60.7	$ 13.7	23%
With Subterminals	86.2	65.2	21.0	32%
Change	+ 11.8	+ 4.5	+ 7.3	

All figures are in millions
Includes subterminal and residual (truck and single-car rail) traffic.
Rail share increases from 74.6 to 102.4 million bushels.

Table 8 summarizes the overall impact upon motor carriers. Although revenues and costs go down by nearly one-half, the bushels handled go up substantially, provided that the subterminals become involved in the grain collection business as previously discussed. Obviously, the average haul distance decreases significantly in the change of function. Table 8 also indicates the present unprofitability of grain haulage by truck.

[1/] The figures shown do not include the cost savings stemming from (1) cutbacks in the frequency of local freights, (2) decreased size of the car fleet, and (3) elimination of branchlines no longer required. Thus, potential savings to the BN are even higher than those indicated.

By going to a collector-type operation rather than competing head-on with unit train service, profitability of trucking operations is expected to be improved.[1]

TABLE 8

IMPACT UPON MOTOR CARRIERS
(ALTERNATIVES 3 and 3A)

	Revenues	Costs	Profit	Return
Present	$ 28.6	$ 29.8	$ - 1.3	- 4%
With Subterminals	15.4	15.9	- 0.4	- 2.5%
Change	- 13.2	-13.9	- 0.9	

All figures are in millions.

Includes subterminal and residual (truck and single-car rail) traffic.

Motor carrier function changes; line haul transport decreases from 35.2 to 7.3 million bushels while collector-type services are projected at 60.1 million bushels.

Table 9 shows the impact upon river terminals and barge operators. Only a portion of the residual Montana grain traffic would continue to move via Snake and Columbia river ports. Table 10 shows the corresponding impact upon farm trucks both with and without the provision of collector-type services.

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[1] Motor carrier profitability in a line haul type operation performed by owner/operators is difficult to pin down, as it depends heavily on the amount of investment in the equipment being utilized, the efficiency of the operation particularly in terms of backhaul utilization, and the amount taken out for salary and/or profit under the proposed collector-type operation, a competitive environment has been assumed with subterminals contracting out trucking operations with costs essentially equalling revenues.

TABLE 9

IMPACT UPON RIVER TERMINALS AND BARGE OPERATORS

	Revenues/Costs
Present	$ 5.1
With Subterminals (Residual only)	0.9
Change	- 4.2

All figures are in millions
Barge traffic decreases from 26.8 to 4.0 million bushels.

TABLE 10

IMPACT UPON FARM TRUCKS
(ALTERNATIVES 3 and 3A)

	Costs*	Costs**
Present	$ 7.3	$ 7.3
With Subterminals	4.0	16.1
Change	- 3.3	+ 8.8

All figures are in millions.

Includes subterminal and residual (truck and single-car rail) traffic.

* Assumes subterminals provide grain haulage for growers located more than 35 miles from subterminal.

** Assumes subterminals do not provide grain haulage service.

Considerable concern has been expressed over the impact which subterminals may have on local highway systems. This concern arises from the damage already done to certain Montana highways by grain trucks and the fear that similar destruction could take place were such traffic shifted to other highways. With subterminals, farm and grain truck vehicle miles of travel are expected to decrease from 27.1 million miles (17.6 million miles within Montana) to 6.7 or 11.1 million miles annually, depending upon whether subterminals offer a grain assembly service or not. Such reductions are expected to occur primarily on the principal grain hauling routes, such as Interstate 90, U. S. 2 and Montana 200. Some increase in truck volumes will occur on segments in the general vicinity of GSTs.

Changes in truck volumes per se do not directly reflect impacts on the pavement and substructure. Consequently, both present truck volumes and the estimated change in farm and grain truck usage have been converted to equivalent annual load applications, which places the impact of vehicles having different weights and wheel and axle configurations on a uniform basis. The total loadings anticipated under Alternatives 3 and 3A were then compared with those occurring under the base case (on a segment-by-segment basis) to determine absolute and relative impact. Table 11 shows the estimated impact of subterminal traffic as a function of highway jurisdiction. Loadings on Interstate and U. S. highway segments would decrease by 13 and 10 percent, respectively, and remain approximately constant on other primary and secondary highways. Loadings on over half of the highway segments would not change appreciably from current levels. Overall, average loadings would decrease by 11 percent.

TABLE 11

ESTIMATED SYSTEMWIDE IMPACT OF SUBTERMINAL-GENERATED TRAFFIC UPON THE STATE HIGHWAY SYSTEM

Percent Change in Equivalent Annual Load Applications
(Percent of Highway Segments)

	Decrease --	Annual Pavement Loadings	-- Increase		
	-30% and greater	-10 to -30%	-10 to +10%	+10 to +30%	30% and greater
Interstate Highways	7	18	73	3	0
U.S. Routes	14	13	56	13	3
MT Routes	8	7	47	17	21
County/Local Roads	5	0	47	34	12

While truck volumes and loadings will increase in the vicinity of subterminals, these effects are localized and do not appear large enough to significantly reduce present levels of service or greatly hasten pavement deterioration. It would be inappropriate to identify the location of these segments, since this study is concerned with the overall feasibility of subterminals and not with the location of specific facilities and attendant local impacts. While it appears that loadings would increase on lower jurisdiction roads, much of the apparent change stems from the lack of truck traffic presently on these facilities, which makes any relative increase in loadings seem more significant than it really is. It is also necessary to place the whole subject of truck volumes in perspective -- that the volumes occurring are a function of the truck and rail modal shares, which in turn are set by comparative rates. It is well to remember that in the past, government has not sought to control the usage of the highway system for transporting grain, even though this action has led to the severe deterioration of at least several highways in Montana and tacit acceptance of a portion of the grain transport cost (infrastructure) by the public sector. Subterminals lead to heightened usage of the rail system, which over the long term removes grain trucks from the highway stem. Further reducing single carload rates to increase rail usage would accomplish the same thing, although this is unlikely given the absence of any economic incentive to the BN.

Conclusions

First of all, there is little doubt that grain subterminals are coming. BN introduction of volume rates and industry response thereto through (1) fairly extensive utilization of the 26-car rate during the first half of 1981, even though this often required cooperative marketing by several elevators located in the same general area or inconvenient loading/switching operations, (2) some 40 requests on file with the BN for engineering plans and cost estimates for expanding tracks at existing grain public warehouses, and (3) construction underway or about to begin for grain subterminal-type facilities located at Rudyard, Plentywood, and Mocassin taken together vividly demonstrates this. Montana no longer has the choice of retaining the previous grain collector and marketing system, or even if it had, would it be in Montana's interest to do so. Grain subterminals will be built primarily because the investors involved are convinced that such facilities are more profitable than the country elevators being replaced. Ironically, the main reason why construction of such facilities have not proceeded faster is the high cost of investment capital at the present time and the long lead time needed to secure property, plan and design the subterminal, and obtain sidetrack construction through the BN. Thus, for the past year, Montana has had a reprieve which gives every appearance of ending in the near future.

Second, if the changeover is left entirely up to private enterprise, then a "mixed" system of a few strategically-located subterminals, a number of "expanded" grain public warehouses, and a reduced number of conventional country elevators will eventually evolve, with the former serving those areas having the greatest density of grain production and the latter areas having sparser production. The underlying motivation in subterminal construction will not be one of serving the grower better or offering a higher price for his wheat, or even strengthening the grain collection system in Montana, but rather capitalizing upon the newly created opportunity for substantial profits through the economies of scale achievable with subterminals and unit trains. In proposing the expansion of existing elevators, the rationale is that of (1) expanding existing plant infrastructure just enough so as to be able to take advantage of the 26-car multiple rate, (2) getting a jump on, or at least keeping up with, nearby competitors, and (3) maintaining the grain collection and marketing business as it has traditionally been conducted. Here again, the motivations center around retaining the traditional modus operandi and hopefully enhancing the profitability of the operation in the face of what is perceived to be a potential takeover and domination by the grain companies or outsiders. In all of this, there is no guarantee that the grower will benefit to any significant degree through either the construction of subterminals or expanded public warehouses, unless competition can be maintained at least in the principal grain-producing areas of Montana.

Third, long-term success as a supplier to world markets depends partly upon the quality of the product being offered and partly upon a state's efficiency in assembling and marketing grain. There is no question that Montana produces some of the finest wheat grown in the United States. However, its delivery system is lacking. Montana today is appreciably behind the other principal wheat-producing states in developing modern grain collection facilities and supporting unit train service. Obviously the state can play catch-up ball. This in itself would not necessarily improve Montana's capabilities vis-a-vis those of competing states, which a likewise are continuing to modernize their grain transport systems. Montana must not replicate what other states are doing, but rather invest in the most modern technology available today for collecting and delivering grain.

Increasing grain exports to Pacific-rim counties and the economies of scale afforded by larger vessels are simultaneously forcing changes in port capabilities. New grain "bulkers" having capacities upwards of one hundred thousand tons are entering revenue service. Existing ports do not have draughts sufficient to handle these vessels. Improvements to existing ports are severely constrained by the cost and environmental impacts of dredging operations. A more practical alternative is to develop a new deepwater port to handle bulk commodities such as grain and coal. Unlike present ports which offer a variety of services, a new port will be a highly automated, specialized bulk commodities transfer facility; storage, blending, inspection, certification, and other processing-type operations associated with present-day terminal elevators will of necessity have to be relocated to strategic inland points. Subterminal loadout operations, unit train movements, and vessel loading will then become highly integrated. Montana must design and build its subterminal facilities as an integral component of an evolving future grain delivery system and not simply as a reaction to present day conditions.

A strong competitive position can only be maintained through investing in modern, high-volume, fully automated subterminal facilities. Modifying existing elevators (or jury-rigging) solely to meet today's railroad-imposed conditions for obtaining volume rates represents a rather short-lived capital investment subject to obsolescence as the conditions surrounding volume rates (e.g., the number of cars and the loading time) are tightened. Such investments simply match the technology already employed by other states and do nothing to improve Montana's competitive position. Maximizing the return to the State can only be achieved by making the collection and delivery systems as efficient as possible.

Fourth, the changeover to subterminals or expanded public warehouses could spawn some problems which either need to be addressed and solved now, or mechanisms established to prevent possible future abuses. The five areas of concern are identified below along with a discussion of appropriate ameliorating actions:

1. Lack of competition in transporting grain via rail. This problem which can lead to monopolistic abuses such as high rates, poor service, equipment unavailability, etc. is not a new one. While truck and truck/barge rates do provide an upper bound on rail rates, a possibly more effective arrangement would be to shift over to contract rates either negotiated directly by the subterminals or by the state as a whole. The key lies in operations which achieve maximum efficiency in the use of the railroad facilities as a means of keeping rate structures below those of competing modes.

2. Lack of competition in marketing grain. The success of subterminals depends upon achieving high throughputs; any system capitalizing upon transport economies of scale inevitably reduces the alternatives available to growers for marketing grain. Competition tends to be between like facilities, rather than between facilities having varying capabilities vis-a-vis volume rates. (In the latter case, the more efficient and larger subterminals tend to drive the smaller elevators out of business.) The key is establishing a system of subterminals, rather than letting private enterprise (in effect) subdivide the grain producing areas into a more-or-less exclusive set of tributary areas. However, it should be recognized that the density of grain production in Montana is probably not great enough to ensure competing subterminals except in the Golden Triangle and the Northeastern portion of the State. Public encouragement and financial support may be requisite to ensure that a system of subterminals offering some degree of choice to growers comes into being.

3. Locational discrimination. As the number of elevators becomes fewer, average farm-to-elevator distances increase. This can adversely affect a substantial number of growers simply because of decisions made in siting subterminals. The way around this problem is a sharing of grain collection costs to minimize the economic hardship which might fall on some growers and not on others. A variety of options exist for accomplishing this built around the subterminal picking up all or a portion of the grain collection costs either for all growers or those located beyond a threshold distance, with the latter being based on distance to the subterminal or the change in distance between the country elevator and the subterminal.

4. Passing on transport cost savings. While the numbers presented in the previous section indicate that subterminals do result in transport cost savings, there is no guarantee that such savings, or a portion thereof, will even reach the growers. Much depends upon who owns the subterminals. If owned by cooperatives or by local governments (either directly or through regional authorities), then mechanisms can be provided for passing the savings back to the growers.

5. Financing needed highway improvements in the vicinity of subterminals. Overall, the impact on highways from grain and farm truck movements should decrease as a consequence of the conversion to grain subterminals. The concern arises not from the lessening of volumes (or load applications) on roads carrying substantial grain traffic (and where the structural damage may already have been done), but rather from localized problems stemming from increased volumes in the vicinity of subterminals. Some improvements may be required for which capital funds will be required. While it can be argued that the reduction in volumes elsewhere on the system permits the reapplication of already existing capital funds, a more direct approach might be to institute a throughput charge (e.g., one cent per bushel) on subterminals, the proceeds of which could be used to finance pavement strengthening and resurfacing on routes principally used by trucks destined to subterminals.

Finally, one must remember that the type of grain collection system to be instituted in Montana will come about as much through positive action in controlling the development of subterminals as through public indecision and inaction. The basic choice is whether Montana should adopt a _laissez faire_ approach towards impending change or to seek a guide subterminal development to (1) achieve an efficient system, yet at the same time maintain adequate competition to prevent excessive profiteering, (2) keep the collection and marketing of Montana grain at least partly in local hands, rather than let the major grain companies and other outside interests totally dominate, and (3) prevent the excesses that could occur during the transition period. The main issues at stake are the degree to which (1) power is concentrated and competition lost in the marketing of grain, and (2) the savings resulting from a shift to volume shipments are returned to the state (and more specifically to the grain growers).

Alternatives for Montana

In the end, the alternatives boil down to two different course of action: (1) leave the implementation of subterminals (or expanded grain public warehouses) largely or entirely up to private enterprise, or (2) initiate some form of governmental intervention and involvement along with private enterprise. The latter should focus on subterminals and could involve any of the following possibilities:

1. Acting in a catalyst and informational role by encouraging present public warehouses and/or cooperatives to merge and form subterminals, but otherwise remain aloof.
2. The above, but with planning and financing capabilities as well. Under this option, the initiative would be left to grain growers and/or warehouse operators with preference being given to grower cooperatives or consolidations of locally-owned public warehouses. Resulting subterminals would be privately owned and operated.
3. The above, but that implementation would be through specially-formed, multi-county, quasi-governmental organizations which would then bond and build subterminal facilities, which would then be leased back to private operators.
4. State ownership and operation of subterminals.

In deciding among the preceding courses of action, the State must be guided by a clear recognition of just where its short- and long-term interests lie, which include (among others):

1. Strengthening Montana's position in worldwide grain markets.
2. Maintaining a balance between the efficiency of large-scale terminal-type operations and the price and service protection afforded by competition in the collection and marketing of grain.
3. Developing effective means to counter monopolistic tendencies detrimental to the State in the collection, marketing and transportation of grain.

4. Seeking an equitable distribution of transport cost savings resulting from subterminal and unit train operations (e.g., at least a portion of the savings is passed back to the growers).

5. Keeping the collection and marketing of Montana grain in local hands, if at all possible.

6. Making the transition to subterminals as painless as possible.

RCAI believes that if the preceding objectives are to be achieved, the State of Montana must become actively involved in the process of modernizing the State's grain collection and transport system. The underlying rationale for this is long-term economic development of the State. Perhaps the best way of approaching this is to create a "package" of the components including (1) a detailed plan and schedule for implementing grain subterminals (and lesser facilities, where needed), (2) contract rates with the BN, (3) financing, (4) appropriate standards and rules to regulate subterminals, (5) funding arrangements for highway improvements, (6) incentives to encourage existing country elevators and elevators to come together to construct and operate subterminals, and (7) development of a deepwater port on Puget Sound which covers the total process. For the State to do less would be to permit the very things considered objectionable to happen. At the same time, the State must not encroach upon the legitimate prerogatives of private enterprise.

One final thought. Time is short. Treating subterminals as a rainy day matter practically guarantees that control will pass to outsiders, with little or no sharing of the benefits of subterminals among Montanans. The great challenge to the agricultural community is to stop living in the past, and to plan and build for the future -- understanding fully the global and long-term implications of the decisions which are or will have to be made, either positively or by default. In a sense, Montana is like a large corporation (the product of which is grain) seeking to increase its profitability which can then be shared among the principal stockholders (i.e., the growers, the elevator operators, and the transporters). Unless internal efficiencies are increased and appropriate controls put in place, the corporation will find itself increasingly less able to compete in the market place -- the world.

I. INTRODUCTION

A. Objective

The basic objective of the "Bulk Freight Grain Transportation System Study" is to determine quantitatively (so far as is possible) the economic and institutional feasibility of modernizing Montana's grain transportation system using grain subterminals to gain the efficiencies of centralized collection and unit train freight movements. Feasibility depends upon whether the proposed subterminals can generate sufficient economic benefits for Montana farmers and elevator operators to overcome the inherent fear and distrust of a major change in the transport and marketing of grain, and whether elevator operators and other grain shippers are willing to combine their shipments into unit train quantities bound for a single destination while retaining their independence and competitiveness in other areas.

B. Background and Perspective

Historically, most grain has moved by railroad under single car rates. In recent years, railroad dominance, particularly on export grain moving to the west coast, has eroded somewhat stemming partly from truck/barge competition and partly from high rates, inadequate service and car supply problems. The unavailability of sufficient railroad grain cars in recent years (at least until the recent embargo on grain sales to the Soviet Union), the relatively slow and unreliable transit times for shipments by rail, and perpetuation of high rail rate structures have fostered truck and barge competition, resulting in a shift away from rail transportation.

This has been aided by U. S. Army Corps of Engineers-sponsored navigation improvements to the Columbia and Snake Rivers and construction of major river terminal facilities at Lewiston, ID and other downstream locations. In spite of the relatively long overland hauls involved (400 to 800 miles, one-way), the rates charged by the firms involved in the truck/barge movement of grain are in most areas competitive with rail rates, even though the costs incurred by the different modes are quite different. While many motives underly the published rail rates (which in the view of many growers and warehousemen are unnecessarily high), the railroads apparently have been content with the major portion of the traffic, leaving the cyclical or overflow portion to motor carriers. This avoids the need to invest in equipment which may not be fully utilized. Since the price of wheat is established by the west coast markets, high transport rates ultimately result in the grain grower receiving less for his product. Unless transport rates can be brought down, Montana grain growers will become increasingly disadvantaged in comparison with producers located in other states.

Grain sub-terminals by themselves cannot solve all of Montana's grain transport problems; companion improvements are also required at west coast ports to improve their efficiency in handling export-moving grain. Grain sub-terminals do offer promise through introducing economies of scale to a transport mode which otherwise has changed very little over the past 40-50 years. Basically, elevators order empty cars from the railroad which are then loaded and forwarded (under single car rates) to a variety of destinations in the northwest and midwest. In spite of the inroads made in recent years by trucks and truck/barge, railroads still dominate in the movement of Montana grain. Little incentive exists by which railroads would improve rail service or offer economic incentives to elevator operators to use the rail system.

Over the years, various alternatives have been proposed, such as multi-car rates, grain trains, subterminals, and unit trains. While these concepts have been discussed off and on for quite some time, until recently only single car rates were offered by the BN. In the fall of 1980, the BN proposed several alternatives to single car rates including (1) 26 cars from two to four origins, (2) 26 cars from a single origin, and (3) 52 cars from a single origin. The first is being offered for a limited time period as a means of encouraging grain public warehouses to make volume shipments. Under this rate structure, elevator operators located along a section of track serviced by the same local local freight could jointly arrange for the spotting of 26 covered hoppers at up to four different locations. Shippers would then be given a minimum time period within which to load out the cars, which would then be assembled into a train for movement to a single destination. The second alternative (26 cars from a single origin) is essentially half of a unit train and the third alternative a full unit train. BN made these volume rates effective on December 1, 1980, along with reduced single car rates.

The proposed BN rate structure does offer the possibility of immediate transport cost savings if the elevator operators are willing to cooperate in their marketing and transportation decisions. It does get around present infrastructure limitations (mainly the lack of suitable trackage and the ability to load out 50 or more carloads in 24 hours without additional switches) which effectively preclude unit train operations today. It may touch off a rash of investments in improved loading facilities and expanded sidings in a rush to achieve competitive advantage through the ability to load out unit trains.

It is important to appreciate the major strengths and weaknesses of competing concepts from both railroad and elevator operator perspectives. Multi-car shipments today are quite feasible at the larger elevators and are being made today, although no rate reduction was offered prior to December 1, 1980. While some switching time is saved over that required in handling single cars, the reduction in terminal costs is relatively small in comparison with the total cost of the movement. No savings occur in terms of transit time, car utilization, or in the number of points served on miles of track operated. Grain trains consist solely of loaded or empty grain cars rather than the mixed freight typical of service in Montana. The only advantage of such trains is the elimination of some switching operations due to the concentration of traffic for fewer West Coast destinations with some reduction in transit time. The major disadvantage is that additional local train operations may be required to handle non-grain traffic. While the concept may be appealing, such trains offer little in operating savings. Both multi-car shipments and grain trains require practically no institutional and/or marketing changes and thus the concept is popular with elevator operators. In short, it represents the continuation of business as usual.

Under the grain subterminal and unit train concept, most of the grain shipments presently made from existing elevators would be trucked instead to a centralized facility where they would be loaded into 100-ton hoppers. Shipments would then be made via unit trains, with the blending and inspection operations being conducted at the grain subterminal rather than at the west coast terminal as is the case at present. The chief virtue of the grain subterminal concept is that it introduces major economies of scale in both terminal and transport operations as reflected by better utilization of the car fleet, more reliable service, and more efficient terminal operations. This concept is the only long-term, technologically advanced solution offering any reasonable promise of reducing the cost of transporting grain -- at least to the major west coast markets. Some grain (e.g., wheat destined to places other than the west coast and most of the barley crop) would either be trucked or continue to move by rail from grain public warehouses under single car rail rates. Implementation of the grain subterminal concept would eventually permit the retirement of light density lines not providing access to a subterminal, carrying overhead or bridge traffic, or not serving commodities other than wheat. Simply introducing subterminals and unit trains in Montana is in itself insufficient to gain the economies possible; companion improvements must be made to grain terminals on the west coast to efficiently unload the unit trains upon arrival.

The evidence is quite clear that past practices associated with the marketing and transport of Montana-produced grain, are on the verge of major change. Either changes are going to occur in an orderly, controlled fashion or there is going to be major upheaval. Under a laisse-faire environment, the large elevators (usually operated by one of the major grain companies) will tend to grow larger (presumably at the expense of the smaller elevators, the independents, and the cooperatives). The alternative is for elevators to voluntarily join together in the marketing and transport of grain, with or without governmental encouragement. Provided that the capital can be raised, it is not too difficult to construct the storage and loading facilities required for loading unit trains. The institutional aspects are a far greater challenge than providing the physical infrastructure. Up until recently, there was little incentive for undertaking the fundamental changes required to realize economic gains from unit train economies of scale. While rail costs (and hence rates) can be expected to go down with volume shipments, this is partially offset by the cost of operating and amortizing the grain subterminal facility and increased grain assembly costs.

Hence the need to first determine the economic feasibility of the grain subterminal concept as applied to Montana and then, if proven feasible, to determine the number, location, and organizational/ institutional mechanisms for implementing grain subterminals.

This document reports on the first phase (i.e., the results of the feasibility investigation) done for the Departments of Highways and Agriculture by Roger CREIGHTON ASSOCIATES Incorporated of Delmar, New York.[1] The second phase would develop public support and prepare necessary enabling legislation to aid in bringing subterminals into being. A third phase would be to proceed with project planning, preconstruction activities, land acquisition, and tariff negotiations for a pilot grain subterminal project.

C. Determining Feasibility

Each of the three major actors (the grain growers, the public warehouses, and the railroads) must receive economic benefits as compared with the present situation, if grain terminals are to be found feasible. Otherwise, the necessary economic incentives simply are not present to overcome the institutional problems bound to arise with such a major change in past grain marketing and transport practices.

Feasibility to grain growers means a higher price for their product. Since the price of wheat and barley is basically determined by the major grain markets, a higher price can only be achieved through a reduction in transport charges. To the extent that existing grain public warehouses continue to act as assembly points, then no offsetting costs are incurred by grain growers in transporting their grain from farm to elevator.

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[1] Associated with RCAI is Radermacher & Associates, a Billings-based transportation and marketing firm, and Robert Peccia & Associates, a Helena-based transportation planning and civil engineering firm.

Should the growers ultimately wind up transporting their product directly to grain subterminals, then some additional savings would occur through the elimination of handling charges at existing grain public warehouses, which is in turn offset by the longer hauling distances typically encountered in transporting grain from farm to subterminal. The above applies only for wheat moving to the west coast; no cost reductions are likely for barley and wheat moving to other destinations under single car rates.

Feasibility to the public warehouses means lower overall transport charges. In other words, the reduction in rail rates (unit train versus single car) must more than offset the annualized cost of converting an existing elevator to be capable of handling multiple carloads, or the costs associated with marketing through a subterminal, which includes (1) transporting grain by motor carrier from the public warehouse to the subterminal and (2) associated handling and storage charges at the subterminal. The latter would include both capital and operating costs. Otherwise, little incentive exists for public warehouses to act as assembly points and market grain through a subterminal.

Feasibility to the railroads means an equal or greater profitability over that now enjoyed from hauling Montana grain. Profitability is simply revenues less costs. The reduction in revenues from substituting unit train for single car rates must be more than offset by (1) operating cost savings from the use of unit trains in lieu of conventional rail service, (2) greater equipment utilization thereby reducing the size of the covered hopper fleet servicing Montana needs, and (3) a reduction in infrastructure costs from abandoning light density lines no longer needed as a result of grain subterminals.

Profitability is also influenced by the degree to which grain subterminals can attract some of the traffic presently moving via motor carrier. Thus net revenues rather than unit savings is the most appropriate measure of the incentives present to railroads.

D. Organization of the Report

This report is comprised of three additional chapters. Chapter II establishes a base against which grain subterminal alternatives can be evaluated, and feasibility ascertained. Chapter III describes and summarizes the analyses performed in assessing grain subterminals. This chapter is supplemented by the rather detailed description of the Grain Transport Costing Model contained in the Appendix. Finally, Chapter IV presents study findings, which are derived by comparing the economics of two futures: one based on a continuation of the single car rail service which was the sole option available to Montana growers and elevator operators prior to December 1, 1980 and the second based on a combination of (1) subterminals and unit trains and (2) residual traffic moving by truck and single car rail service.

II. THE PRESENT SITUATION

The purpose of this chapter is to establish a base against which grain subterminal alternatives can be evaluated, and feasibility ascertained. Specifically, this chapter presents information on (1) Montana-produced grain potentially handled by subterminals, (2) present transport costs and charges via the different modes -- rail, motor carrier, barge, (3) grain public warehouse handling and storage costs and charges, and (4) traffic moving over the rail and highway networks in Montana. It seeks to reduce the complex world of grain marketing and transport decisions to a form applicable to macro-scale economic analysis.

A. Grain Production

Ample statistics are readily available on the acreage, amount, and value of the wheat and barley grown in Montana each year.[1/] Table 1 summarizes a small portion of this information for 1970-1979. Several rather important trends are observable: (1) the sizable variability from year to year in the amount of grain produced, which is a function of natural conditions (e.g., weather) and to a lesser extent economic factors (price, demand), (2) the relatively constant amount of acreage planted or harvested each year, and (3) the gradual shift over the years from barley to wheat. Unfortunately, Table 1 does not readily identify a representative figure for the annual production of barley and wheat to be used in assessing the feasibility of grain subterminals.

[1/] Specifically, information produced by the Montana Department of Agriculture in cooperation with the U. S. Department of Agriculture, Montana Crop and Livestock Reporting Service.

TABLE 1

MONTANA GRAIN PRODUCTION DURING THE 1970's
(all numbers in thousands)

	Wheat (all varieties)			Barley				
Year	Acreage Planted	Acreage Harvested	Total Bushels	Acreage Planted	Acreage Harvested	Total Bushels	Total Acreage Planted	Total Acreage Harvested
1970	3,506	3,383	85,167	1,800	1,714	65,132	5,306	5,097
1971	4,516	4,314	112,011	1,740	1,680	58,800	6,256	5,994
1972	4,130	3,704	98,831	1,820	1,707	64,013	5,950	5,411
1973	4,235	4,052	96,714	2,100	2,000	60,000	6,335	6,052
1974	5,020	4,857	120,108	1,370	1,250	37,500	6,390	6,107
1975	5,130	4,975	155,925	1,360	1,300	50,700	6,490	6,275
1976	5,580	5,415	167,295	1,220	1,170	52,065	6,800	6,585
1977	5,400	5,060	130,920	1,650	1,520	55,480	7,050	6,580
1978	5,031	4,840	146,050	1,500	1,375	59,125	6,531	6,215
1979	5,363	5,125	116,475	1,100	1,040	40,560	n.a.	6,165
Ave.			122,950			54,338	6,345	6,047

Sources: Montana Agricultural Statistics - State Series 1867-1976 (April 1978)
Montana Agricultural Statistics, Volume XVII (December, 1978)
Selected County Agricultural Statistics, 1978-1979, (March, 1980)

Montana Department of Agriculture in cooperation with the U.S. Department of Agriculture, Montana Crop and Livestock Reporting Service.

RCAI has somewhat arbitrarily chosen 1979 as the base year; in this particular year, Montana grain growers produced 116.5 million bushels of winter, spring and durum wheat and 40.6 million bushels of barley. Wheat production in 1979 was slightly below the mean value for the 1970's, and thus can be considered as a somewhat conservative overall figure. On the other hand, barley production in 1979 reached the lowest point in the decade. Since wheat is expected to be the predominate grain handled by subterminals, the non-representativeness of barley production is not a major concern. In addition to the above, a considerable amount of grain transport-related data were available for 1979, thus strengthening the rationale for selecting this particular year. However, it should be emphasized that wheat production in any future year can easily be up to 40 percent higher or lower than the chosen production level, and that similar variations in barley production are likewise possible.

Table 2 shows the amount of wheat and barley produced in 1979 by county. Also shown is the amount of long-term storage available both at grain public warehouses and "on-farm". Grain produced is not necessarily grain marketed and transported. The availability of large amounts of storage both in country elevators and particularly in on-farm silos provides appreciable flexibility to the grain grower in seeking the most advantageous moment to market his product. Other factors affecting marketing (besides price/demand) include transport availability and the need to provide room for future crop storage.

TABLE 2

1979 WHEAT AND BARLEY PRODUCTION BY COUNTY
(ALL FIGURES IN THOUSANDS OF BUSHELS)

County	Wheat	Barley	GPW Storage	On-Farm Storage
Beaverhead	239.2	635.9	88	1,387.4
Big Horn	1,997.0		510	3,901.1
Blaine	3,972.1	892.2	1,642	6,387.1
Broadwater	976.3	940.7	140	3,175.5
Carbon	461.8	274.1	327	979.4
Carter	1,004.6	257.5	-	1,191.8
Cascade	4,271.8	1,549.8	4,839	12,913.8
Choteau	12,056.5	3,502.2	2,920	29,400.0
Custer	838.3	267.5	368	1,871.2
Daniels	3,652.3	162.7	1,475	11,875.0
Dawson	3,316.1	474.1	1,804	5,633.6
Deer Lodge	4.5		-	83.0
Fallon	1,702.5	212.6	598	3,004.9
Fergus	4,072.9	2,585.5	2,414	10,635.2
Flathead	518.4		598	2,199.7
Gallatin	1,580.6	1,672.1	2,474	5,918.5
Garfield	1,186.3	475.3	-	2,993.8
Glacier	2,690.4	3,635.0	1,682	6,634.8
Golden Valley	373.2	166.2	29	948.1
Granite	13.3		-	175.0
Hill	11,192.0	1,570.5	4,795	27,500.0
Jefferson	117.8	91.5	24	346.9
Judith Basin	2,035.5	1,628.2	368	4,720.7
Lake	346.1		205	1,340.0
Lewis & Clark	179.0	425.1	-	295.7
Liberty	5,772.5	489.6	1,890	15,128.9
Lincoln	5.0		-	7.5
McCone	4,014.5	461.7	710	9,461.8
Madison	197.9	142.5	100	506.3
Meagher	130.0	449.5	208	595.4
Mineral	9.8		-	21.7
Missoula	57.1		100	256.2
Musselshell	349.2	110.1	-	811.3
Park	459.9	285.7	295	965.6
Petroleum	83.9	20.6	-	260.7

TABLE 2

1979 WHEAT AND BARLEY PRODUCTION BY COUNTY
(ALL FIGURES IN THOUSANDS OF BUSHELS)
Continued

County	Wheat	Barley	GPW Storage	On-Farm Storage
Phillips	2,394.3	757.3	477	5,169.8
Pondera	4,871.3	3,352.5	2,775	11,048.1
Powder River	979.6	34.0	-	1,482.4
Powell	27.8		29	268.0
Prarie	1,115.0	256.6	315	1,590.6
Ravalli	101.0		170	470.9
Richland	2,875.4	673.3	1,125	8,151.9
Roosevelt	6,235.0	324.0	3,385	13,406.7
Rosebud	1,072.6	206.9	93	1,968.4
Sanders	80.0		48	147.8
Sheridan	6,403.2	384.9	1,744	14,766.1
Silver Bow	0.0		-	27.0
Stillwater	1,028.7	614.8	489	2,382.8
Sweet Grass	131.5	188.4	65	611.0
Teton	3,625.8	3,896.0	2,218	13,414.5
Toole	6,244.8	1,492.1	3,603	11,094.0
Treasure	220.3	161.1	31	718.3
Valley	5,583.7	716.2	2,080	10,830.0
Wheatland	466.2	557.5	636	712.3
Wibaux	1,023.5	97.3	254	2,793.2
Yellowstone	2,117.0	1,021.8	3,282	4,201.5

Unfortunately, grain production statistics at the county level are too aggregate to use in computing transport costs. On the other hand, similar figures for individual farm production are just not available. As part of its responsibilities to monitor crop acreage and production, the Montana state office of the Agriculture Conservation and Stabilization Service has over the years collected crop production data directly from growers by county agents and then aggregated this information to the sub-county and county level. RCAI has utilized these same areal units, which in this study are referred to as grain-producing units or GPU's. Grain production statistics have been assembled for a total of 44 counties and 194 identified GPU's[1/] shown in Figure 1. These counties produced 115.1 million bushels of wheat in 1979.

Areas of intense farming activity within each GPU were pinpointed on Montana Department of Community Affairs land use maps to determine its centroid, which in turn was used in determining highway distances to GPWs.

B. Markets

Shifting from the supply side to markets for Montana-produced grain, Table 3 illustrates the general destinations of the wheat and barley movements in 1979, as reported to the Montana Department of Agriculture by grain public warehouses. The primary destinations for both wheat and barley are the Pacific North Coast and the interior of Oregon or Washington, for both export and domestic shipments, with the latter consigned to flour mills and malt houses. Wheat destined for Idaho is trucked to Lewiston where it is loaded on barges for movement to Portland. Wheat and barley shown as destined for Montana generally

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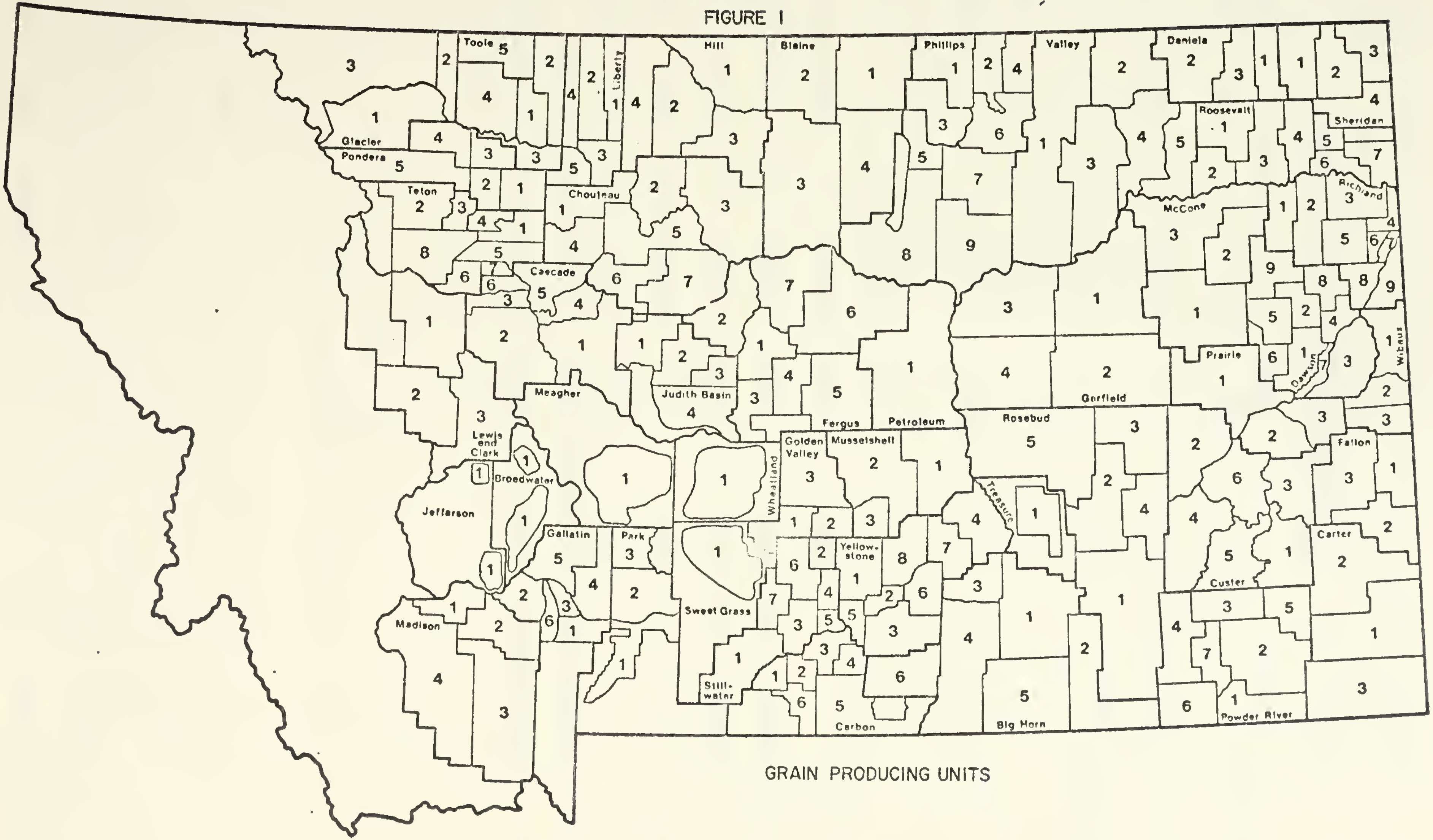
[1/] Eleven counties in the western part of Montana have been excluded because of their limited grain production and grain public warehouses. These include Beaverhead, Deer Lodge, Flathead, Granite, Lake, Lincoln, Mineral, Missoula, Powell, Ravalli, and Sanders Counties. Of the 194 GPU's, data are available for 188.

FIGURE I



GRAIN PRODUCING UNITS

TABLE 3

1979 GRAIN MOVEMENTS BY DESTINATION
(all figures in thousands of bushels)

Destination	Wheat				Barley			
	Rail	Truck	Total	%	Rail	Truck	Total	%
Pacific North Coast	29,938	5,748	35,686	41	2,843	1,069	3,911	24
Interior Oregon or Washington	18,473	9,114	27,587	32	1,649	632	2,280	14
Idaho	80	9,001	9,081	10	236	656	892	5
California	204	1,851	2,055	2	92	2,964	3,056	18
Colorado	0	41	41	0	303	5	308	2
Utah	9	827	837	1	1	532	533	3
Minneapolis/ St. Paul	1,089	1,100	2,189	3	1,494	541	2,035	12
Duluth/Superior	744	59	803	1	41	29	70	0
Other Minnesota	38	509	547	1	362	27	389	2
Montana	5,196	3,379	8,575	10	1,860	1,095	2,955	18
Total	55,834	31,696	87,531	100	8,932	7,717	16,649	100

Source: Montana Department of Agriculture - Grain Transport Data

Note: Columns will not add up to totals shown due to the omission of minor movements.

represents shipments to storage elevators for later reshipment to west coast markets. Barley moving to California is destined to feed lots; barley to Minnesota is probably destined to a maltster. The statewide volumes reported to the Department of Agriculture are considerably less than those shown in Table 1; the difference being attributable to (1) grain bypassing the public warehouses, (2) incomplete reporting to the Department, (3) on-farm retention of some of the grain for seed or as cattle feed, and (4) losses from shrinkage or spoilage. Again, given the rather vast amount of storage existing in Montana, substantial differences can occur between grain produced and grain marketed from year-to-year although over the long run these figures should balance out. Grain reported as being marketed in 1979 includes a portion of the 1979 harvest plus portions of previous year's harvests.

The main finding to be drawn from Table 3 is that over 90 percent of Montana-produced wheat eventually winds up at Pacific North Coast ports or is destined to other locations in the interior of Oregon or Washington, whereas only half of the barley moves to these same destinations. In addition, two-thirds of the wheat and barley not moving to the above destinations is being transported by truck, of which a sizable portion is thought to occur as a backhaul to other motor carrier movements. Given the dispersed nature of non-west coast markets, the relatively small volumes involved, and apparent shipper preference for motor carrier transport, RCAI concludes that these markets do not have unit train/ subterminal potential.

Turning again to west coast markets (excluding California), Table 4 provides a listing of the principal export houses, flour mills, and maltsters through which Montana-produced grain is marketed. Also included is information on the present capabilities of these terminals in handling volume shipments. While the principal locations shown

TABLE 4

WEST COAST MARKETS

PLANTS: Owner/Location	Export (EX) Flour Mill (FM) Malt Houses (MH)	Bushel Capacity In Millions	No. 8 Hr. Shifts Plants Operate Daily	No. Of Cars Plant Unloads Per 8 Hr. Shift.	Present Capacity For Spotting Cars	Max No. Cars Per Unit Practical For Plant
Fisher/Seattle	FM	2.0	1.0	22	17	25
Centennial Mills:						
Spokane	FM	.8	1.0	10	10	15
Portland	FM	.6	1.0	8	4	10
Terminal Flour Mills:						
Portland	FM	.9	2.0	12	7	12
General Foods:						
Pendleton	FM	.8	1.0	8	8	8
Great Western Malting:						
Vancouver	MH	1.5	1.5	9	8	25
Bunge/Portland	EX					
NPGG/Kalama	EX	4.0	2.0	40	35	75
Continental:						
Longview	EX	5.0	2.0	35	55	50
Tacoma	EX	3.0	1.7	75	150	75
United Grain:						
Tacoma	EX	5.0	2.0	52	30	25
Vancouver	EX	5.0	1.0	82	50	25
Cargill:						
Portland	EX	8.1	1.5	38	54	25
Seattle	EX	4.2	1.0	130	175	50
Columbia/Rivergate	EX	1.3	1.0	40	50	50
LDC/Portland	EX	1.8	2.0	32-40	27	25

tend to be either Seattle or Portland, the former has in recent years increasingly specialized in feed grains (mainly corn) while the latter (and nearby Columbia River ports) has concentrated on handling export wheat. While a number of different terminals handle export wheat, they are all located in close proximity to one another. Furthermore, the same rail lines would be utilized to reach these west coast markets. Given the concentrated location of the terminals handling export wheat, the sizable volumes involved, and the historic tendency to utilize rail transport, RCAI concludes that a high potential for unit train service does exist. This, however, is not to suggest that Portland and nearby ports are ready for unit train operations; major improvements and restructuring of railroad operations are needed to reduce present delays and inefficiencies. Otherwise, the full potential of Montana subterminals and unit train service will never be reached.

It is obvious that export terminals have the throughput necessary to support unit train service. What about the flour mills, malt houses, and feed lots which do not handle comparable volumes or have the track facilities needed for unit train service? In recent years, rates on wheat moving to domestic locations (flour mills) have been approximately five percent higher than export rates to reflect the rerouting and transit privileges traditionally offered by the railroads. The single car rate reductions implemented by the BN on December 1, 1980 (1) eliminate the differential between wheat moving to export terminals and domestic locations, (2) terminate transit privileges, and (3) institute an extra charge for rerouting. This standardization of rate structures could eventually lead to (1) the phasing out of interior flour mills, with replacement facilities being located closer to the market areas being served rather than at an intermediate location, (2) a shift to truck for the distribution of flour, and (3) a reduction in the domestic market for Montana-produced wheat. Flour mills in the Portland area may be able to reduce costs by purchasing wheat through export houses rather than rely on continued single car service. With respect to barley, the BN's December 1, 1980 rate structures do not change the single car rates, nor do they offer any multi-car rates for this commodity. In addition, relatively little barley has found its way into export markets. Although this could change in the future, RCAI has, for the purposes of this study, excluded barley as a commodity having unit train/subterminal potential.

Most wheat and barley is marketed by some 230 grain public warehouses (GPW's) presently in existence in Montana. Figure 2 shows the location of these facilities -- their concentration in the "Golden Triangle", the northeast corner of the state, and along the "Hi-Line." Grain not marketed through GPW's is sold to "track buyers" who predominantly utilize motor carriers in transporting wheat and barley to the purchaser. Some movement by rail is also employed. Little information exists on the total amount or ultimate destination of grain bypassing the GPW's.

Throughput volumes and the location of markets to which grain was shipped were developed for each of the GPWs in Montana for calendar year 1979. This information was derived from five different data sources, including:

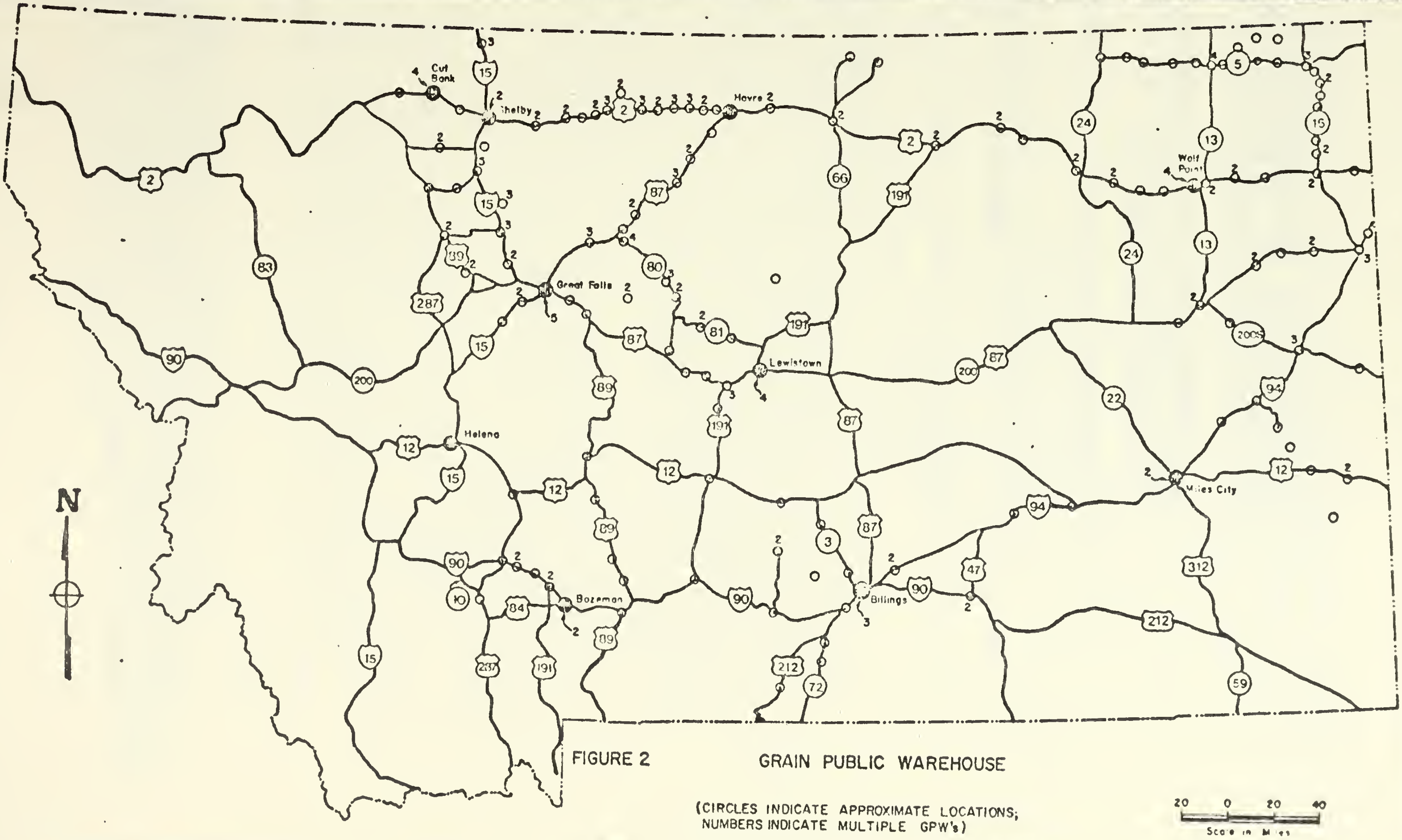


FIGURE 2

GRAIN PUBLIC WAREHOUSE

(CIRCLES INDICATE APPROXIMATE LOCATIONS;
NUMBERS INDICATE MULTIPLE GPW's)

- The Grain Movement System, a computerized information system maintained for the Montana Department of Agriculture by the Crop and Livestock Reporting Service of the U.S. Department of Agriculture.
- The Montana Wheat and Marketing Research Commission's records on bushels of wheat and barley on which assessments were paid to the commission.
- A mailout-mailback survey of all GPW's in the state conducted in June, 1980.
- Aggregated traffic data for both origins and destinations for wheat and barley as prepared by the BN.
- Disaggregate traffic data by station as provided by the Milwaukee Road.

It was necessary to make use of this combination of sources since no single data source was complete either in terms of containing all GPWs or reflecting total yearly throughput. The amount of grain moving through individual elevators and the system on the statewide level are crucial to establishing the economic feasibility of GSTs. A great deal of time was spent in reconciling the differences among data sources and arriving at more or less accurate numbers for 1979 wheat and barley throughputs, as well as the distribution between rail and truck modes to various destinations.

The methodology fashioned to accomplish this task exploited the positive attributes of each of the available data sources, relying upon reasoning, professional judgement, and knowledge of grain operations in Montana to make the best estimate in the face of conflicting or missing data.

Once GPW thruputs were estimated, it was then possible to apportion GPU production to GPWs, using distance minimization and long-standing trade patterns as guides.

While production levels of grain may vary considerably from year to year due to a combination of factors such as soil management, fertilization, amount of moisture, moisture retention of soil and cropping practices, the quantity of grain shipped out of Montana in a given year appears to be relatively stable. As a general rule of thumb, in years of low levels crop production more grain moves out of on-farm storage and in years of high levels of production more grain goes into on-farm storage. While no direct relationship exists between grain produced and grain marketed, reasonable and defensible estimates of the GPU-to-GPW-to-market wheat and barley flows were developed.[1/]

C. Transport Utilized

The principal markets for Montana-produced grain and the distribution of grain shipped to these markets in 1979 serve as the "base year" used in the study. Essentially, this holds constant the amount of grain shipped to the west coast, and hence the potential grain traffic for GSTs and unit trains.

Of the nearly 120 million bushels of wheat moving through the GPW system in 1979, almost 110 million bushels (91.8 percent) was shipped to west coast destinations by rail, truck, or truck/barge. (This amount of grain was assumed to be the potential "market" for GSTs and unit train operations.) While shipment size, destinations, and mode choice varied appreciably, the following five movement patterns predominate:

[1/] Quantities of grain moving directly from GPUs to markets and bypassing GPWs (so-called track buying) have been excluded from the analysis, largely because of a lack of information on such movements. It is assumed that these types of transactions will continue in the future at more-or-less present levels.

- Pacific North Coast (Rail and Truck). This refers to a collection of terminals located in Portland, OR and Kalama, Longview, Seattle, Tacoma, and Vancouver, WA. The vast majority of these terminals are involved exclusively in handling export grain; several however do process grain (e.g., flour milling). Shipments made direct to PNC terminals are largely by rail although direct truck shipments do occur, largely as backhauls to other movements.[1]

- Interior Oregon/Washington (Truck/Barge). Wheat shipped to interior Oregon and Washington by truck is received at terminals on the Columbia-Snake inland waterway system located at The Dalles, OR and Almota, Burbank, Central Ferry, Kennewick and Pasco, WA. From these river terminals, wheat is shipped by barge to Portland, Vancouver and other Columbia River deepwater ports for eventual export in ocean-going vessels. Again, the large majority of grain movements to river terminals are backhauls.[2]

- Interior Oregon/Washington (Rail). Almost without exception, wheat shipped to interior Oregon and Washington by rail is processed into flour at Pendleton, OR and Spokane and Cheney, WA. Prior to December 1, 1980, all rail shipments to these terminals were made under "domestic" rates with transit privileges; since that time, the BN has consolidated export and domestic rates and eliminated transit privileges.

- Idaho (Truck/Barge). Wheat shipped to Idaho is received primarily at Clearwater River terminals at Lewiston, ID where it is transferred to barge for shipment downstream (some grain is also handled at Clarkston, WA). Much of the Montana grain moving to Lewiston and Clarkston is again backhaul movements.[3] Truck movements to Lewiston and Clarkston can either be made via Route 12 (Lolo Pass) or by Interstate 90 to Spokane and then south on Routes 95 or 195 (the latter are better routes, but with a greater over-the-road mileage). Both Lewiston and Clarkston are relatively convenient to GPWs located in the Golden Triangle or southwestern Montana.

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[1] While occasional headhaul shipments are made to take advantage of a unique marketing opportunity (e.g., where temporal or product considerations permit transport premiums), the long over-the-road distances involved work against the use of trucks on this movement. Study has assumed that 90 percent of the roundtrip miles are loaded miles.

[2] Study has assumed that 85 percent of the roundtrip miles are loaded miles for the truck portion of this movement.

[3] Study has assumed that 80 percent of the roundtrip miles are loaded miles for the truck portion of this movement.

Table 5 summarizes the five major movement patterns in terms of volume and line haul distance, revenue, cost and net.

TABLE 5

MAJOR GRAIN MOVEMENTS

Mode/Dest	Volume (000 bu)	Ave.Dist. (mi.)	No.of LHV	Ave Rev. ($/bu)	Ave Cost ($/bu)	Net ($/bu)
Rail to PNC	44,963.3 (40.9%)	1080	15,111[2/]	$1,103	$0.716	$0.388
Rail to Int OR/WA	29,723.5 (27.0%)	910	10,014[2/]	1,186	0.623	0.562
Truck to PNC	9,020.5 (8.2%)	945	8,870[3/]	0.966	1.069	- 0.103
Truck/Barge to Int OR/WA	15,274.8 (13.9%)	648	15,019[3/]	0.770	0.810	- 0.039
Truck/Barge to Lewiston, ID	10,999.2 (10.0%)	509	10,815[3/]	0.738	0.714	0.024
Total-All Modes & Destinations.	109,981.3[4/] (100%)	906	25,525[2/] 34,705[3/]	1.032	0.734	0.297

[2/] Rail cars (combination of covered hoppers and grain boxes - 3,067 bu).

[3/] Grain trucks (1017 bu)

[4/] 73,514.3 via rail, 36,467.1 via truck, and 26,763.8 via barge.

Also important is the distribution of this traffic over Montana's highway and rail networks. Figure 3 presents base year farm and grain truck volumes (westbound wheat) on selected highway system segments. Figure 4 presents corresponding carload volumes on major rail system segments.

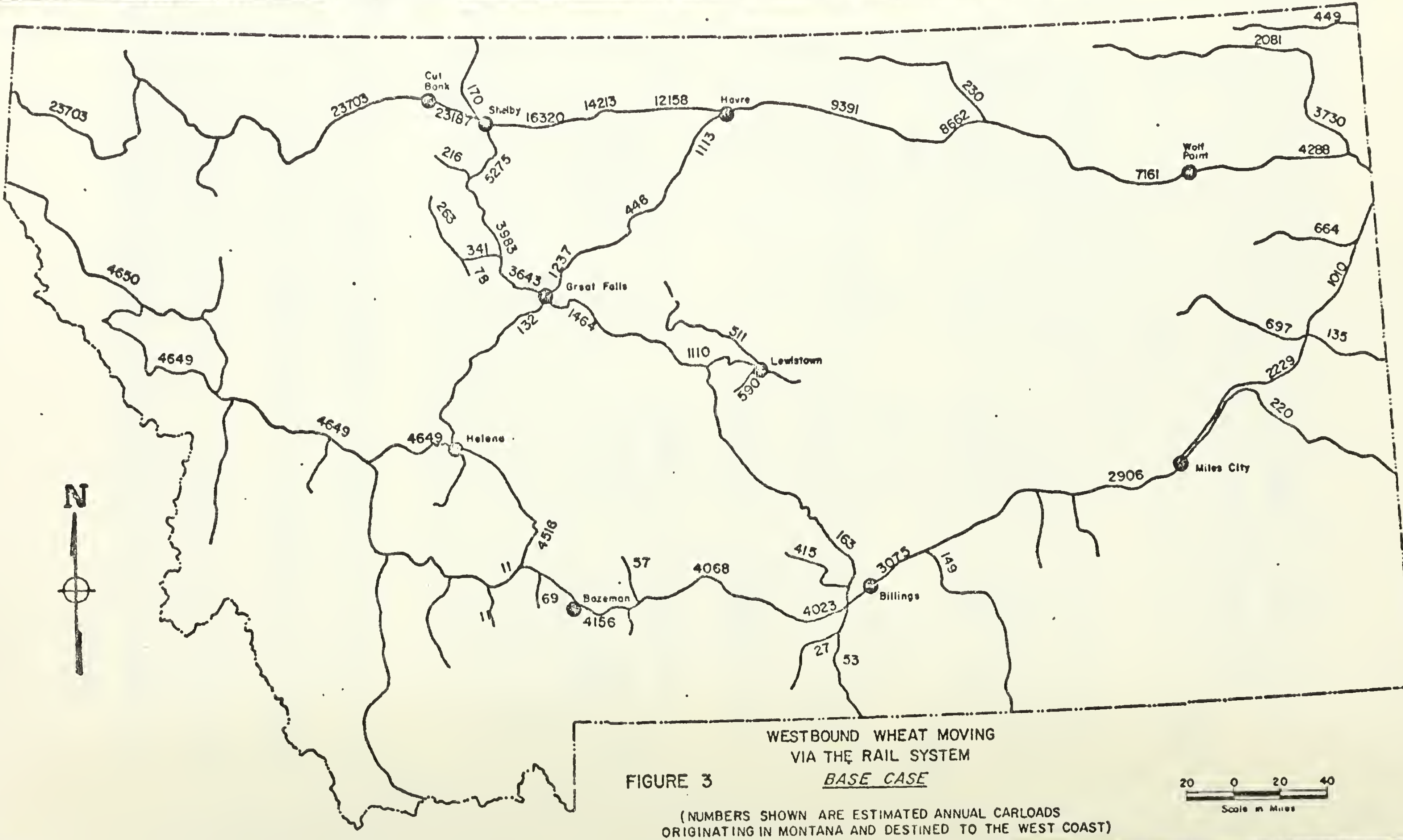

FIGURE 3

WESTBOUND WHEAT MOVING
VIA THE RAIL SYSTEM
BASE CASE

(NUMBERS SHOWN ARE ESTIMATED ANNUAL CARLOADS ORIGINATING IN MONTANA AND DESTINED TO THE WEST COAST)

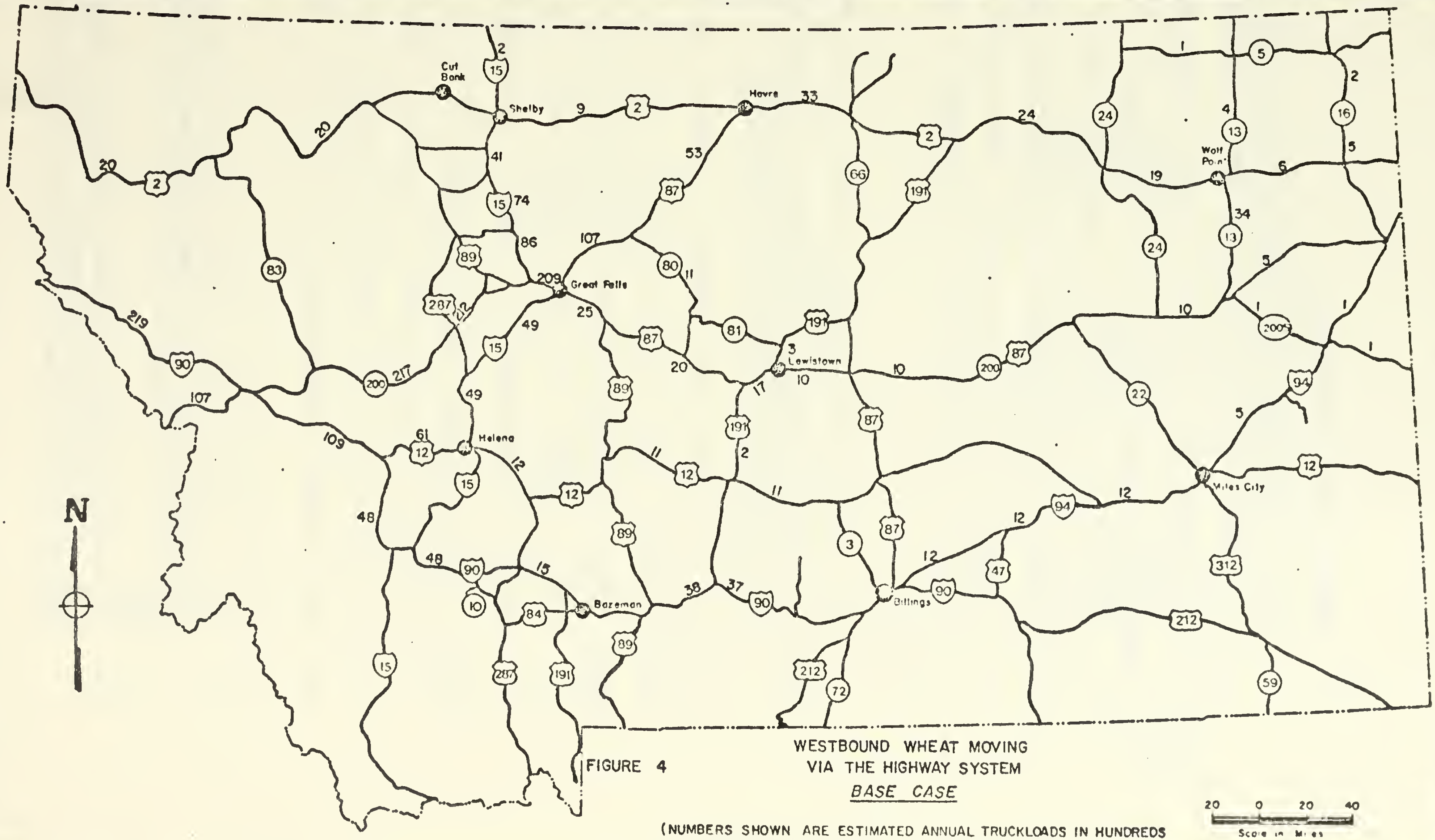

FIGURE 4

WESTBOUND WHEAT MOVING
VIA THE HIGHWAY SYSTEM
BASE CASE

(NUMBERS SHOWN ARE ESTIMATED ANNUAL TRUCKLOADS IN HUNDREDS ORIGINATING IN MONTANA AND DESTINED TO THE WEST COAST)

D. Transport Costs and Charges

Table 6 shows present or base case carrier and elevator revenues and costs. Total revenue to carriers (or charges to growers and elevator operators) were estimated to be $133.4 million, of which the largest portion ($74.4 million) was spent on rail transportation.[1] Total costs were estimated to be $119.07 million, leaving a net profit of $14.34 million, most of which was earned by the BN. Truck costs were estimated to be $1.26 million higher than revenues.[2] GPWs revenues were estimated at $18.01 million and costs at $16.15 million, leaving a profit of $1.86 million.

Table 7 shows the distribution of transport costs among the different modes. The average transport charge amounted to $1.214 per bushel, of which $1.083 was spent for transport or elevation costs leaving a profit of 13 cents per bushel to the transporter or elevator operator. Over half the revenue (56 percent) and just over half the costs was spent on rail transport, for which railroads earned an estimated profit of over 18 1/2 cents per bushel. In contrast, truck revenues were estimated to be 21 percent of total revenues, and truck costs 25 percent of total costs, resulting in an estimated average loss of 3 1/2 cents per bushel. Elevator charges and costs amounted to 14 percent of total revenues and costs. Clearly evident is the dominance of railroads in transporting grain and the overall profitability of this traffic for them.

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[1] The rail revenues shown are based on the rate structures implemented on December 1, 1980. Actual yearly revenues are probably higher, given the rate structures in effect for the first 11 months of 1980.

[2] The trucking of grain to Lewiston, ID and other Snake and Columbia River ports has become quite marginal. Costs can exceed revenues although this is a situation that cannot be continued indefinitely.

TABLE 6

ESTIMATED CARRIER AND ELEVATOR REVENUES AND COSTS
(all figures in thousands)

	Revenue	Cost	Net Profit	Percent Profit
Rail	$ 74,432.2	$ 60,689.8	$ 13,742.4	22.6
Truck	28,550.2	29,816.7	- 1,262.5	-4.2
Barge	5,142.4	5,142.4	-	-
GPWs	18,014.8	16,154.5	1,860.3	11.5
Farm Trucks	7,262.9	7,262.9	-	-
Total	$133,402.5	$119,066.3	$ 14,336.2	

TABLE 7

DISTRIBUTION OF TRANSPORT REVENUES AND COSTS
(all figures in dollars per bushel)

	Revenue	%	Cost	%	Net Profit
Rail	$0.677	56	$ 0.552	51	$ 0.187
Truck	0.260	21	0.271	25	- 0.035
Barge	0.047	4	0.047	4	-
GPWs	0.164	14	0.147	14	0.017
Farm Trucks	0.066	5	0.066	6	-
Total	$1.214	100	$ 1.083	100	$ 0.130

III. MODERNIZING THE GRAIN TRANSPORT SYSTEM

The purpose of this chapter is to describe and summarize the analyses performed in assessing improvements to Montana's grain transport system -- namely subterminals, or GSTs. Chapter II focused on the situation as it exists today. Chapter III describes the work done in simulating a hypothesized future where the vast majority of westbound wheat moves via GSTs.

This chapter is concerned with GST feasibility, recognizing that corporate and institutional factors cannot be divorced entirely from economic factors in determining feasibility. However, there is a fundamental principle involved that transcends institutional aspects -- that GSTs will be utilized only if it is in the economic interest of grain growers and GPWs to do so. Otherwise, present grain collection and marketing practices will continue.

A. Grain Subterminals

While a GST is similar in function to a GPW (i.e., collection and marketing of grain), it is like comparing the latest Detroit offering with a Model T. Both do the job, but the former offers the potential of far greater efficiency. Long-term success as a supplier to world markets depends partly on the quality of the product being offered and partly upon a state's efficiency in assembling and marketing grain. There is no question that Montana produces some of the finest wheat produced in the United States. However, Montana today is appreciably behind the other wheat-producing states in developing modern grain collection facilities and supporting unit train service.

The term "grain subterminals" can mean different things to different people. RCAI views the GST as the hinterland component of a grain assembly and delivery system consisting of GSTs, rail lines/unit train service, and new or vastly improved port facilities.[1/] Under this concept, RCAI visualizes that a number of port terminal elevator functions (e.g., storage, blending, inspection, certification) would be transferred back to GSTs located at strategic inland points. Not only would the GST act as a regional assembly point and "pump house" for loading wheat into unit trains, but it also would perform most of the traditional GPW service functions, except for long-term storage. Subterminal loadout operations, unit train movements, and vessel loading would then become highly integrated and coordinated. This of course differs considerably from prevailing thought, which attaches the title of subterminal to any facility able to load out 26 carloads in 24 hours irrespective of the

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[1/] Increasing grain exports to Pacific-rim counties and the economies of scale afforded by larger vessels are forcing major changes in the character of port facilities. New grain "bulkers" having capacities upwards of one hundred thousand tons are entering revenue service. Existing West Coast ports do not have the draughts necessary to handle these vessels. Improvements to existing ports are severely constrained by the cost and environmental impacts of dredging operations. Rather than attempt to rebuild existing ports, a more practical alternative is to develop a new deep water port specially devoted to transferring bulk commodities from rail to ship. Competitive pressures and economics will force a decentralization of grain storage and processing functions back to the hinterlands, with the new port facility acting simply as a transfer facility.

difficulty involved.[1] GSTs cannot be created simply by adding trackage to existing GPWs.

The major alternatives are (1) continuation of the modus operendi built around GPWs and single car rail service, (2) adding GSTs, but keeping GPWs as local collection and marketing points, and (3) adding GSTs, simultaneously phasing out GPWs. Alternative 1 is no longer a viable course of action, but merely serves as a reference point against which to quantify the changes being brought by GSTs. Under Alternative 2, GPWs would continue to function in the same fashion as at present, except that westbound wheat would be shipped by truck to the subterminal instead of being loaded into covered hopper cars at the GPW. GPWs would retain their tradional marketing function, except that cooperative decisionmaking (with other GST users) would be necessary to assemble and market unit train loads of wheat.

Under Alternative 3, the role of GPWs would change drastically in that the GSTs would largely supplement GPWs in assembling and marketing westbound wheat.[2] Along with the transport economies of scale, GSTs would probably become their own merchandizers. Remaining GPWs would concentrate on marketing barley and wheat either destined to other markets and low volume shipments by truck or single car rail.[1/] Although not examined in this study, a fourth alternative involving improvements to 40-50 existing GPWs to be able to handle 26 car units is conceivable.

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[1] Modifying existing elevators (or jury rigging) simply to take advantage of today's railroad-imposed conditions for obtaining volume rates represents a rather short-lived capital investment subject to obsolescence as the conditions surrounding volume rates (e.g., the number of cars and the loading time) are tightened. Not only are track improvements required, but upgraded elevator machinery to achieve the 5 to 10 minute loading time per carload is ultimately required. Usually, such facilities are better achieved by starting from ground-up rather than through modification of essentially obsolete elevators.

[2] The study has assumed that GSTs will specialize in volume shipments and not take on low volume truck or rail movements, although this traffic could be readily handled by GSTs.

Grower shipments through GSTs will occur only if there is an economic incentive to do so (i.e., the price per bushel offered by the GST is greater than that offered by the GPW). Under the concept proposed by RCAI, GSTs would be required to provide a collector service (using motor carriers) to move grain from the more distant farms to the GST, or offer allowances in lieu thereof, to offset the longer farm-to-market hauls that many growers would face with the phase-out of the GPW system.[2/] New uses would be found for some of the redundant GPWs.[3/]

[1/] The study has estimated that 15 percent of present truck movements and 50 percent of rail movements to destinations in interior Oregon or Washington will continue to be made by truck and single car rail, respectively. This "residual" traffic represents low volume shipments and other circumstances not conducive to unit train movements.

[2/] There is no present requirement that GSTs supply trucking services to growers. Such a service, which will only come about through regulatory intervention, helps neutralize the economic disadvantages of growers not located in general proximity to GSTs as well as forcing the utilization of a mode more cost efficient than farm trucks. Acceptance of GSTs will be significantly improved if the costs of local transport can be equitably spread across all growers. An allowance or discount system based on distance from the GST represents another possibility.

[3/] The reduction in the number of GPWs will occur through survival of the fittest, with those having a strong barley or durham wheat trade having the best chance of survival. Much depends upon ownership, condition, grain characteristics, traditional markets, and location vis-a-vis the GST. Some GPWs may choose to change functions, such as becoming feed and seed outlets. Others will probably be sold to growers for use as private storage, a trend which is already happening. Still others may become storage adjuncts to GSTs. No projection was attempted concerning the fate of individual GPWs.

Of the estimated total westbound wheat traffic of 109,981,400 bushels, 88,687,400 bushels (or 80.6 percent) was found to be reasonably available to GSTs.

B. Location of Grain Subterminals

The purpose of the study was to determine the economic feasibility of GSTs. The methodology developed for the study was not a mathematical model for determining the optimal number and location of GSTs. However, it did become necessary to conceptualize on the possible number and approximate location of GSTs needed to serve Montana growers, and to use this information in calculating costs.

In hypothesizing GST locations, factors considered included (1) coverage of the state (i.e., more or less equal opportunity for grower access to GSTs), (2) minimizing distance between GPUs and the nearest GST, (3) capitalizing on published rail rate structures -- especially points where sizable differentials occur, and (4) minimizing the total number of subterminals to keep total infrastructure and operating costs as low as possible, which in turn keeps handling and storage charges down. Recognizing that a good location from a regional perspective could be moot if a satisfactory site was not available, an inspection was made of some 56 different sites to ensure the availability of at least an acceptable site for a GST within its tributary area.1/

1/ Judgments were largely made on a qualitative basis. Site factors considered included (1) size and terrain, (2) ownership, (3) rail service, (4) highway access, and (5) the availability of utilities. A key factor was the availability of land on either side of the GST to allow for construction of side tracks which are uninterrupted by grade crossings. Existing elevator sites were not excluded although most of the sites evaluated consist of vacant land, most of which is presently owned by the BN and presumably available on a lease basis.

In the end, ten locations were selected as study sites for GSTs. RCAI emphatically emphasizes that these sites were selected only for the purpose of determining the overall economic feasibility of GSTs and are not endorsed or recommended in any way as sites for GSTs.[1/] Once selected, each GPU was assigned to a GST based on highway routes/distances and long-standing patterns of local/regional commerce.[2/] Figure 5 illustrates the resulting GST tributary areas, which are based on the following hypothesized GST locations:

Site No.[1/]	Location	Thruput[2/]	Site No.[1/]	Location	Thruput[2/]
01	Pompeys Pillar	4.72	28	Havre	14.04
09	Benz	3.46	32	Saco	5.15
20	Mission	2.64	37	Macon[3/]	12.56
24	Moccasin	4.18	40	Homestead	6.37
26	Kershaw [3/]	14.41	52	Conrad	21.16

1/ Numbers used in site survey and analysis performed by Gene A. Radermacher for RCAI. Subterminal numbers are preceded by the subscript "7" in computer printouts.

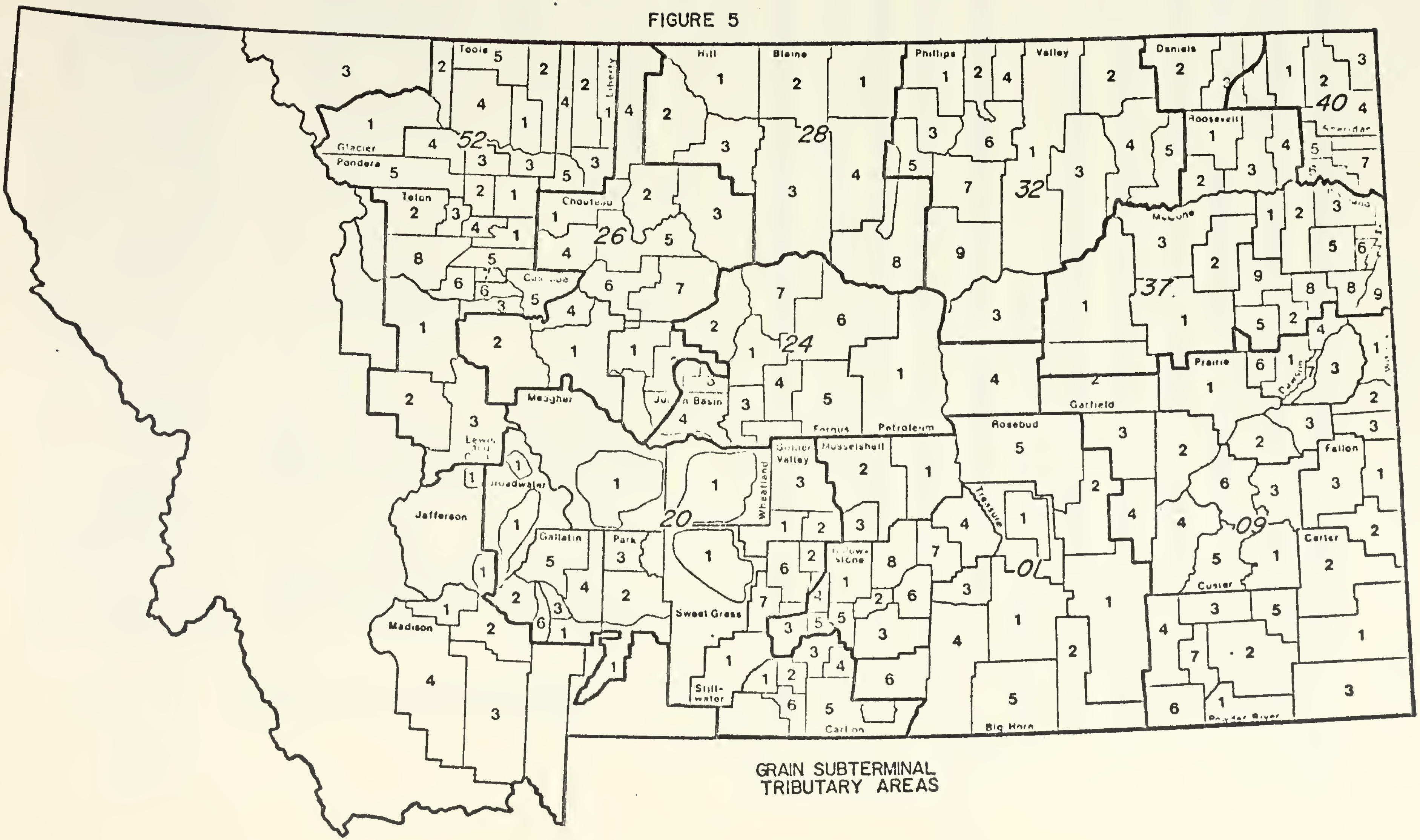
2/ In millions of bushels.

3/ Site coincident with an existing (although relatively modern) elevator owned/operated by United Grain and capable of being upgraded/expanded to a GST.

[1/] Pinpointing GSTs was necessary to (1) determine the applicable rail rate, (2) compute GPW to GST distances and hence trucking costs, and (3) compute GPU to GST distances and hence farm and grain truck costs.

[2/] GPU assignment was done empirically. An optimizing model based on choosing the GPW offering the lowest overall transport distance could have been developed for this purpose, but was not done because of the time (and cost) required to prepare the highway network inputs and the possibility of answers which would be inconsistent with existing commerce.

FIGURE 5



GRAIN SUBTERMINAL
TRIBUTARY AREAS

Also shown is the potential annual throughput for each GST, which varies appreciably by location.[1/] Throughputs by themselves do not establish facility feasibility. Consequently, further hypothesizing of the characteristics, operations and cost of GSTs was necessary to establish an appropriate regime under which the feasibility of GSTs might be ascertained, individually and collectively.

C. Subterminal Costs and Revenues

Recognizing the vast amount of on-farm storage existing in Montana and the storage capabilities of GPWs, most of which will still be used for private storage even though the GPW function may be phased out, the storage capacity of GSTs was set at 500,000 bushels.[2/] This storage capacity is intended to support blending and load-out requirements and not be a duplication of the long-term storage presently provided by GPWs and on-farm storage. Subterminal land acquisition, site preparation, side track construction, and elevator construction and equipping costs were estimated to be $3.31 and $4.21 million for 500 thousand and one million bushel facilities, respectively.[3/] GSTs would have the

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[1/] Obviously, the highest volumes occur at elevators serving the Golden Triangle and Northeast Montana on account of the high concentration of grain production in these areas. With respect to the former, GST locations at midpoint locations along the "sides" of the Triangle are generally preferable in terms of reducing farm-to-market distances than a "point" location, such as Great Falls (Havre is an exception partly because a GST at this location can tap wheat from GPUs located to the east).

[2/] This was increased to one million bushels for the four high-throughput GSTs (greater than ten million bushels annually) in Alternative 3 (where existing GPWs are phased out). It was felt that additional storage was necessary to ensure adequate supplies of grain to meet contractual commitments during extended periods of adverse weather.

[3/] Cost estimates utilize information supplied in part by Jacobson and Sons Construction Co., Inc. of Bismarck, ND.

capability of unloading all types of vehicles; however under Alternative 2 delivery would continue to be by farm truck to GPWs and by grain truck from GPWs to GSTs. Under Alternative 3, farm trucks are assumed to deliver directly to GSTs if the GPU was located 35 miles (one-way) or less from the GST. GSTs would arrange for contract trucking to move grain from GPUs located more than 35 miles from the GST, or offer appropriate discounts to partly offset the geographically-created farm-to-market cost distortions caused by GST siting decisions. The handling/charge scenario first contemplated consisted of a uniform charge irrespective of location of 10.5 cents per bushel handling and 0.1 cents per bushel per day storage (with no free time). This resulted in higher volume facilities supporting the lower volume facilities, as indicated in Table 8.

TABLE 8

GST Costs and Revenues Under Uniform Handling Charges

GST	Location	Thruput[1]	Revenue[2]	Costs[2]	Net[2]
01	Pompeys Pillar	4.72	$ 642	$ 710	$ -68
09	Genz (Terry)	3.46	512	645	-133
20	Mission (Livingston)	2.64	425	603	-178
24	Moccasin	4.18	585	682	- 97
26	Kershaw (Ft. Benton)[3]	14.41	1816	1333	483
28	Havre[3]	14.04	1769	1313	456
32	Saco	5.15	689	732	- 43
37	Macon (Wolf Point)[3]	12.56	1620	1236	384
40	Homestead	6.37	816	795	21
52	Conrad[3]	21.16	2518	1680	838
			$ 11,392	$ 9,730	$ 1,663

1/ In millions of bushels

2/ Revenues, Costs, and Net in thousands of dollars for Alternative 3. For Alternative 2, revenues are $140-$150 thousand less, costs are $121 thousand less, and the net is $23-$30 thousand less on account of the use of 500,000 bushel GSTs at all 10 locations.

3/ GSTs having a storage capacity of one million bushels.

These results, based on the continuation of Department of Agriculture practice of establishing "ceilings" for storage and handling charges, imply common ownership and cross-subsidization, a situation only likely under government ownership and operation of GSTs. Under private operation, GSTs simply would not be built unless profitable, which would mean no GSTs outside of the Golden Triangle and northeast Montana.

Consequently, an additional alternative consisting of a variable handling charge and a 0.1 cents per bushel storage charge (no free time) was tested under the proviso that each GST had to earn a ten percent profit. Under this situation, handling charges ranged from 7.3 to 19.5 cents per bushel and produced the results shown in Table 9 .

TABLE 9

GST Costs and Revenues Under Variable Handling Charges

GST	Location	Thruput[1]	Revenue[2]	Costs[2]	Net[2]
01	Pompeys Pillar	4.72	$ 781	$ 710	$ 71
09	Benz (Terry)	3.46	710	645	65
20	Mission (Livingston)	2.64	663	603	60
24	Moccasin	4.18	751	682	68
26	Kershaw (Ft. Benton)[3]	14.41	1467	1333	134
28	Havre[3]	14.04	1445	1313	132
32	Saco	5.15	805	732	73
37	Macon (Wolf Point)[3]	12.56	1359	1236	123
40	Homestead	6.37	875	795	80
52	Conrad[3]	21.16	1847	1680	167
			$ 10,703	$ 9,730	$ 973

1/ In millions of bushels.

2/ Revenues, Costs, and Net in thousands of dollars for Alternative 3. For Alternative 2, revenues are $131-$134 thousand less, costs are $121 thousand less, and the net is $10-$13 thousand less on account of the use of 500,000 bushel GSTs at all locations.

3/ GSTs having a storage capacity of one million bushels.

While self sufficiency has been obtained, handling charges have gone up for the lower throughput GSTs, which raises the possibility that the total charges via a GST may be greater than via a GPW. As mentioned earlier, GSTs will be utilized only if it is in the interest of grain growers and GPWs to do so. This possibility will be examined in Chapter IV through comparing, on a GPU basis, unit transport charges via GPWs and single car rail service versus GSTs and unit train service. If the former is less than the latter, then no incentive exists for using the GST. Erosion of traffic base for a particular GST forces an increase in the handling and/or storage charges to be assessed, and a further erosion in the traffic base. It is possible that one or more of the smaller throughput GSTs may not survive this viability test.

On the other side of the coin, could the GST tributary areas having throughputs greater than, say, ten million bushels annually support multiple GSTs, thus retaining competition in the assembly and marketing of grain at least for the prime grain growing areas? In other words, do the savings in assembly costs (i.e., trucking to the GST) offset the higher infrastructure and operating costs associated with multiple GSTs.1/ If the competing facilities are located at the same railroad station or in close proximity, the total cost will be greater. Such makes little sense, economically. However if the high volume tributary areas were further subdivided, some net savings might be possible. This possibility will be examined in Chapter IV based on the following hypothesized subdivision of the four high-volume tributary areas:

1/ Also involved are the rail rates applicable to the additional GST(s), which can be either higher or lower.

26 Kershaw
28 Havre — further subdivided into additional GSTs at Inverness, Great Falls, and Chinook
52 Conrad

37 Macon — further subdivided by a second facility located at Sprole.

D. Unit Train Costs and Revenues

The procedures used for costing volume traffic are adapted with few exceptions from two primary sources: (1) the record of Ex Parte 270 (Sub. No 4), Investigation of Railroad Freight Rate Structure-Coal, where the Section of Cost and Valuation of the Interstate Commerce Commission supplied adjusted regional average costs, and (2) documents and working papers developed by A. T. Kearney, Inc., under contract to the Commission. The Kearney method, in essence, develops more specific cost adjustments along the lines delineated by the Section of Cost and Valuation in Ex Parte 270. Most of the modifications to Rail Form A costs advocated by Kearney are detailed in a publication entitled "An Improved Regulatory Costing Methodology for Class I Railroads", dated November, 1977. The methodology in its entirety is highlighted in the documentation provided for the 1977 Revenue Freight Contribution Study which was also developed by A. T. Kearney, Inc.[1]

Several adjustments were made to the basic Kearney formula. The more important of these include (1) reduction in car costs for volume traffic (capital cost, maintenance, and depreciation), (2) reduction in terminal switching costs, and (3) an adjustment in train service costs to eliminate the way train portion of the mileage.

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[1] In a notice of proposed rulemaking in Ex Parte 320 (Sub No. 3), "Rail Market Dominance and Related Considerations", dated January 17, 1980, the Commission expressed its approval of the Kearney methodology by participants in regulatory proceedings. Thus Kearney approach is the most acceptable formula which has been developed to date for costing volume movements.

Unit train rates are the per bushel or hundredweight rates published by the BN and GST revenues are simply the product of the bushels times the published rate effective on December 1, 1980 for that location.

E. Highway System Impacts

One concern that crops up repeatedly is the potential impact upon Montana's highway system. Specifically, will potential increases in farm or grain truck volumes or changes in vehicle types lead to increased pavement deterioration and resulting maintenance or reconstruction expenses which could be prevented by not implementing GSTs.

Figure 6 presents farm and grain truck volumes (westbound wheat) on selected highway system segments for Alternatives 3 and 3A. These can be compared against similar figures presented earlier in Figure 4 for the base case. A careful study of the two figures indicates that the picture is mixed -- volumes on some segments increase while on others a decrease takes place. Volume changes by themselves, however, are not a good proxy for highway system impacts.

The process of estimating highway impacts is essentially one of determining loadings and estimating remaining pavement life under two different futures -- one with GSTs and one without. The basic process first involves estimating truck volumes, which are then converted to pavement loadings over a period of time -- usually one year. Pavement structure, age and condition information is then obtained and used (along with the anticipated loadings) to estimate the remaining pavement life both with and without GSTs. Changes in pavement life are then to be translated into reduced or additional annual infrastructure costs.

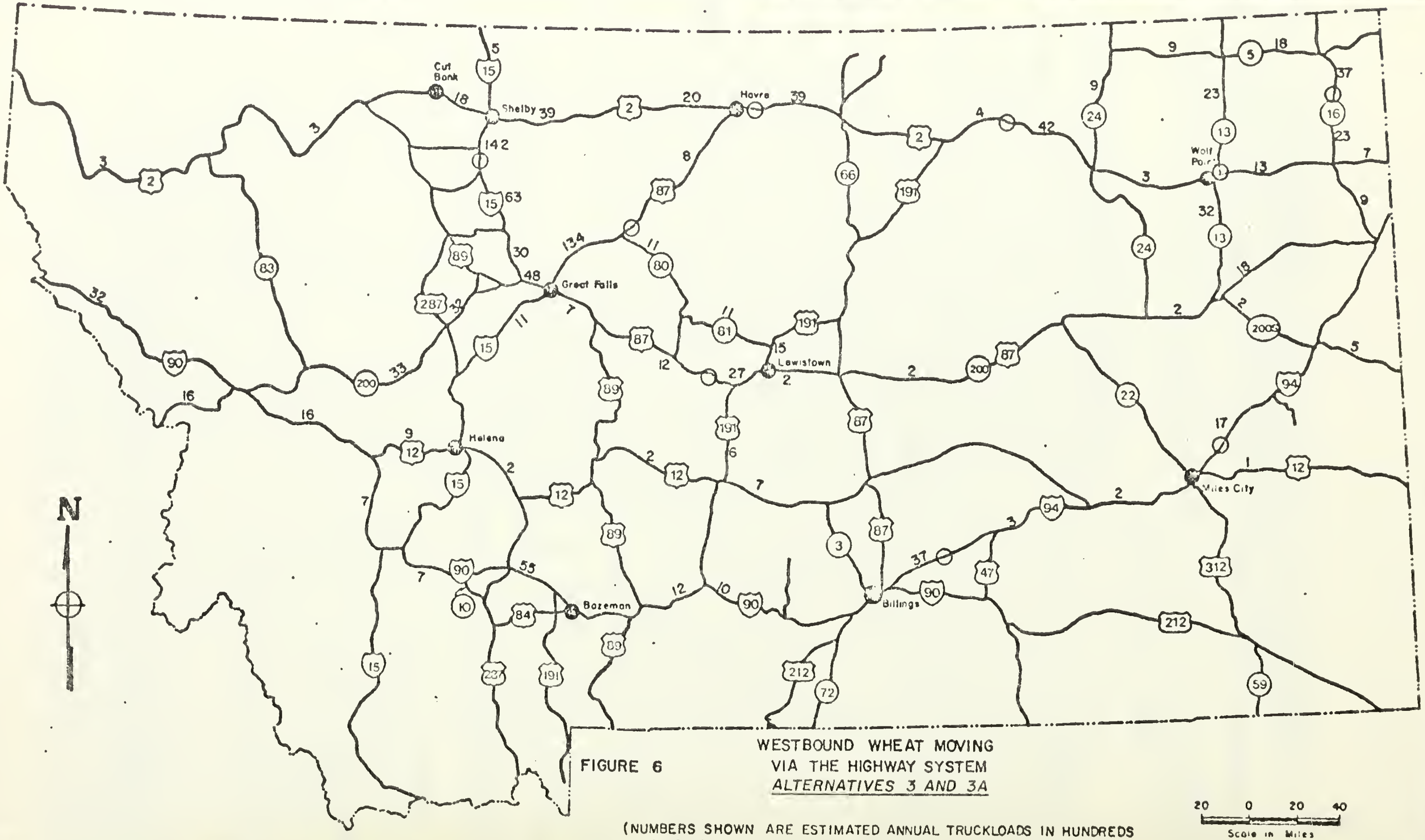

FIGURE 6

WESTBOUND WHEAT MOVING
VIA THE HIGHWAY SYSTEM
ALTERNATIVES 3 AND 3A

(NUMBERS SHOWN ARE ESTIMATED ANNUAL TRUCKLOADS IN HUNDREDS ORIGINATING IN MONTANA AND DESTINED TO THE WEST COAST)

The above is normally done on a segment basis and the results summed to provide an overall estimate of highway system impacts.

A detailed study of truck volumes and resulting loadings; pavement structure, age, and condition; remaining life; and investment needs has never been done in Montana.[1] Such a study is a major effort well beyond what can reasonably be done as part of the Grain Subterminal Study. The reason for this is threefold: (1) the limited amount of information on truck loadings by segment, (2) the very limited amount of quantitative information available on pavement condition obtained through deflection testing, and (3) the rather extensive effort involved in devising and carrying out the computer-based computations using the pavement structure information contained in the MDH's Highway Information System file as the base file.[2] This is not intended to minimize the need for a comprehensive pavement performance and needs study to provide essential information regarding required capital expenditures over a 20 to 30 year period.

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[1] More abbreviated, sample-based studies have been undertaken as part of the Federal Highway Administration's Highway Needs Studies (1970, 1974, and more recently in 1980).

[2] Segment-based truck loading information is limited to the 16 special truck weight stations sampled every two to three years as part of a FHWA mandated program. While Montana does have an extensive network of truck weighing stations operated on a year-around basis, the data exists solely as operator logs (i.e., no data reduction or translation to magnetic tape). Deflection testing, which involves applying a known loading to a pavement section and then measuring the deflection occurring, is the most scientific way of estimating remaining life, but is a slow, tedious, and costly process. Otherwise, estimates must be computed based on expected life (based on the physical characteristics of the pavement section) less the vehicle loadings that have taken place since the pavement was constructed.

Recognizing that any significant increase in highway impacts is most likely to occur in the vicinity of GSTs, and that reduction in impacts is most likely along the principal grain-hauling routes to the west, (e.g., Route 200), an approach based on identifying the significance of changes in equivalent annual load applications (EALA) has been adopted for approximating highway impacts.[1/] The computations are based on farm trucks being a 50/50 mixture of two and three axle single units (with dual tires on the rear axles) carrying between 350 and 500 bushels (425 average) and grain trucks being 18-wheel tractor semi-trailer rigs carrying between 800 and 1200 bushels (1017 average).[2/] The computations were carried out both assuming the vehicles were strictly legally loaded as well as being moderately overloaded.[3/] The following computational process was utilized:

1. First, farm and grain truck volumes are summarized on a link basis for each of the alternatives as well as the base case. From this, the change in farm and grain truck volumes caused by the implementation of GSTs is computed.

[1/] EALA is a number equivalent to the effects on the pavement and substructure of a comparable number of 18,000 pound axle loadings occurring over a one year period.

[2/] A 50/50 split was judged to be characteristic of the Golden Triangle and Northeast Montana. Two axle single unit trucks are thought to be more prevalent in other areas.

[3/] Information obtained from several major GPWs indicated probable overloadings, especially for farm trucks. MDH information obtained through weigh station records indicates general compliance. However, it must be recognized that most farm-to-GPW movements occur partly over county highways and are unlikely to pass through MDH-operated weigh stations. Similarly, some overloading of grain trucks does occur either legally through permits or simply through scheduling the movement to occur when the applicable weigh station(s) is not in operation. Such information is readily obtainable through CB communications.

2. Next, farm and grain truck volume changes are translated into EALA equivalents, which neutralizes the difference in vehicle types.

3. Using MDH (a) estimates of annual daily traffic by link, (b) classification counts giving the percentage of vehicles which are trucks, and (c) EALA factors computed from truck weight study data, base year traffic is translated into EALA equivalents on a link basis.

4. The EALA equivalents computed in steps 2 and 3 are compared by dividing the prospective change (step 2) by the base traffic (step 3) to determine the relative impact of GSTs.

The results obtained from applying the above procedure are presented in the following chapter.

F. Rail System Impacts

Figure 7 presents carload volumes (westbound wheat) on major rail system segments for Alternatives 3 and 3A. These can be compared against similar figures presented earlier in Figure 3 for the Base Case. A careful study of the two figures indicates that the overall volumes on the Hi-Line increase somewhat while the volumes across southern Montana decrease slightly. This reflects two conflicting trends (1) the diversion of truck to rail occurring with unit train service, and (2) the exclusive use of the 100 ton hopper car in transporting grain via unit train as opposed to the extensive usage of grain box cars as well as covered hoppers in 1979. Also evident is the concentration of shipments at GSTs rather than GPWs. Thus rail system impacts are largely limited to modest changes in segment volumes and distributional changes in loading points, which, depending upon which GPWs survive and which do not, should reduce the long-term need to retain agriculturally-based feeder branchlines.

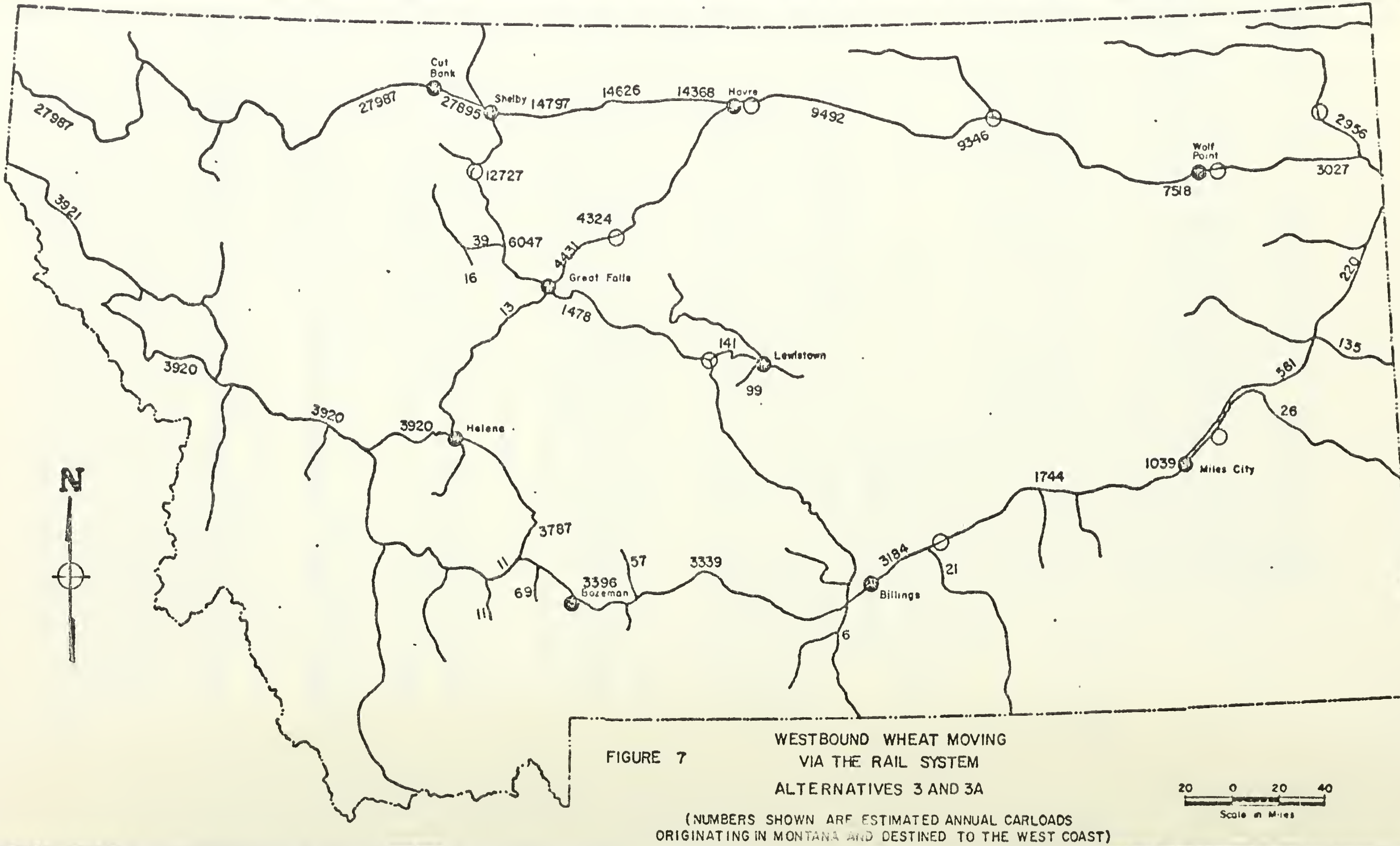

FIGURE 7

WESTBOUND WHEAT MOVING
VIA THE RAIL SYSTEM

ALTERNATIVES 3 AND 3A

(NUMBERS SHOWN ARE ESTIMATED ANNUAL CARLOADS
ORIGINATING IN MONTANA AND DESTINED TO THE WEST COAST)

IV. STUDY FINDINGS

The purpose of this chapter is to present study findings, which are derived by comparing the economics of two futures: one based on a continuation of the single car rail service which was the sole option available to Montana growers and elevator operators prior to December 1, 1980 (but using the single car rates now in existence), and the second based on the combination of subterminals/unit trains and residual traffic moving by truck and single car rail service.[1] Residual traffic includes three different situations: (1) GPUs located outside the practical range of GSTs, distancewise, (2) potentially divertable traffic but where the cost via GPWs and single car rail service is less than via GSTs and unit trains, and (3) low volume, special destination, or high priority shipments not appropriate to GST and unit train service. Findings are presented as (1) charges to growers, (2) revenues to the carrier or elevator, and (3) costs to the carrier or elevator, both in the form of totals and as a unit charge, revenue, or cost per bushel. The universe in all cases is 109,981,400 bushels of westbound wheat.

Charges, revenues, and cost information has been developed, by alternative, for five levels of detail: (1) the GPU, (2) the GPW, (3) County, (4) GST tributary area, and (5) state as a whole:

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[1] It is important to recognize that some of the subterminal benefits that would have been claimed have already been usurped by the BN when it lowered its single car rates on December 1, 1980. The overall savings in transport charges from the implementation of this change amounts to $10.36 million or 13.9 cents per bushel. On a station basis, these savings ranged from 2.7 to as high as 25.5 cents per bushel for export wheat with the greatest savings occurring in the northeastern part of the State. In practice, rail rate reductions may or may not be passed back to growers in the form of higher prices for wheat (presumably depends somewhat upon local GPW competition). There is no guarantee that these rail rate reductions will be maintained in the future, however.

Only the last two levels will be summarized in this report.[1/]

A. Are Subterminals Feasible as a Supplement to Existing Public Warehouses?

Keeping GPWs in place, if economically feasible, have two great virtues -- retaining the traditional assembly and marketing/service organizations at the local level and capitalizing upon the economies-of-scale made possible by GSTs and unit trains. Admittedly, such is more expensive, as both GPWs and GSTs become middlemen between the grower and the major grain markets.

Table 10 summarizes on a statewide basis transport system revenues and costs for Alternatives 2 and 2A. The table shows that were GSTs added to GPWs, the resulting charges to growers would actually be slightly greater (an average of five to six cents a bushel) than those occurring at the present time under single car rail service, even though the overall transport cost to carriers and elevator operators would go down slightly. The slight decrease in transport costs (three cents per bushel) stems from the efficiency of unit train rail service (in comparison with single car rail and trucking to a river port) which is partially offset by the added cost of GSTs.

Any new grain collection system that increases overall charges to growers makes little economic sense. Hence the finding that GSTs are not feasible as a supplement to existing GPWs.

B. Are Subterminals Feasible as a Replacement for Existing Public Warehouses?

The infeasibility of a potential system retaining the best of both worlds (GPWs and GSTs) does not necessarily mean that GSTs are not in

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[1/] Information at the GPU and GPW level cannot be released publically for confidentiality reasons. Information at the county level is available for public inspection at the headquarters offices of the Montana Departments of Highways and Agriculture.

TABLE 10

TRANSPORT SYSTEM REVENUES AND COSTS (INITIAL)

	Alternative 2[1/]		Alternative 2A[2/]	
	Total (000)	per Bushel	Total (000)	per Bushel
Subterminals Only[3/]				
Revenues/Charges	$ 113,363.0	$ 1.278	$ 112,726.3	$ 1.271
Cost to Carriers	93,327.8	1.052	93,327.8	1.052
Profit to Carriers	20,036.2	0.226	19,399.5	0.219
With Residual[4/]				
Revenues/Charges	139,803.6	1.272	139,166.8	1.266
Cost to Carriers	115,636.2	1.052	115,636.2	1.052
Profit to Carriers	24,167.3	0.220	23,530.6	0.214
Difference from Base Case[4/]				
Revenues/Charges	+ 6,401.1	+ 0.058	+ 5,764.3	+ 0.052
Cost to Carriers	- 3,430.0	- 0.031	- 3,430.0	- 0.031
Profit to Carriers	+ 9,831.1	+ 0.089	+ 9,194.4	+ 0.083

	Alternative 3[1/]		Alternative 3A[2/]	
	Total (000)	per Bushel	Total (000)	per Bushel
Subterminals Only[3/]				
Revenues/Charges	$ 95,033.2	$ 1.072	$ 94,343.6	$ 1.064
Cost to Carriers	76,317.8	0.861	76,317.8	0.861
Profit to Carriers	18,715.4	0.211	18,025.8	0.203
With Residual[4/]				
Revenues/Charges	121,473.8	1.105	120,784.1	1.099
Cost to Carriers	98,627.2	0.897	98,627.2	0.897
Profit to Carriers	22,846.5	0.208	22,156.9	0.202
Difference from Base Case[4/]				
Revenues/Charges	- 11,928.7	- 0.109	- 12,618.4	- 0.115
Cost to Carriers	- 20,439.0	- 0.186	- 20,439.0	- 0.186
Profit to Carriers	+ 8,510.3	+ 0.077	+ 7,820.7	+ 0.071

[1/] Fixed handling charge
[2/] Variable handling charge
[3/] Based on 88,687,400 bushels (all 10 subterminals)
[4/] Based on 109,896,700 bushels

Montana's long-term economic interest. Table 10 also summarizes on a statewide basis transport system revenues and costs for Alternatives 3 and 3A. The table shows that were GPWs replaced by GSTs, the resulting charges to growers would drop by roughly $12 million annually (11-11 1/2 cents per bushel) while the costs to carriers and elevator operators would drop by over $20 million (18 1/2 cents per bushel).[1/] Profits to carriers would increase by roughly $8 million (7-7 1/2 cents per bushel), an increase of 55-60 percent. This does not include the 14 cents per bushel average reduction in transport charges received by growers as a consequence of the BN's December 1, 1980 action lowering single car rates for westbound wheat.

While these savings are not spectacular, they do imply that, at least in the aggregate, GSTs are feasible if implemented as replacements for existing GPWs. This however raises questions concerning whether growers will find it in their economic interest to utilize GSTs in lieu of GPWs and whether all ten GSTs are viable.

C. Are Each of the Ten Subterminals Viable?

GSTs will be utilized only if the price received for wheat is greater than that offered by GPWs. All other things being equal, price is inversely related to transport charges. Utilization of GSTs can be determined by comparing total transport charges from GPU to the west coast markets via GPWs and single car rail service versus GSTs and unit train service. If the former is less than the latter, then no economic incentive exists for using the GST.

[1/] Reductions in transport charges are considered to be benefits to growers although there is no guarantee that they will indeed be passed back in the form of higher wheat prices.

The above comparison was made for the 188 GPUs tentatively assigned to GSTs. Of these, the GPW with single car rail service was found to be less costly for nine GPUs under Alternative 3 and 14 GPUs under Alternative 3A. Although four GSTs are potentially affected, only in one case was the difference in unit costs and the volume of grain involved deemed significant, as indicated by Table 11. To maintain viability, any erosion of the traffic base for a particular GST forces an increase in handling and storage charges. The results obtained indicated that this could be done for three of the four GSTs and still retain viability. The fourth -- GST #20 at Mission (Livingston) -- was judged not to be viable and was then dropped.1/ Traffic originally assigned to this GST was added to the residual traffic handled by GPWs and conventional rail and truck transport.

D. Are Multiple Subterminals Feasible in the Golden Triangle and Northeast Montana?

In an age of increasing concentration of economic power, retention of competition in situations where the added cost is minimal provides an important safeguard against monopolistic or discriminatory practices. This principal is potentially applicable in the Golden Triangle and Northeast Montana where the volumes handled by four GSTs are substantially above the threshold volume needed for viability.

Figure 8 illustrates the general relationship between GST throughput and total, handling, and storage charges for a 500,000 bushel facility.

1/ While not done, elimination of the hypothesized GST at Mission could lead to location adjustments for the other two "southern" GSTs. For example, relocation of GST #01 to Laurel or Columbus and GST #09 to Miles City represents a possibility worth investigating in further subterminal planning.

TABLE 11

SUMMARY OF GPU TO MARKET MOVEMENTS WHERE GPWs ARE LESS COSTLY THAN GSTs

Alternative 3

Grain Movement Less Costly Via GPWs

Subterminal	Bushels (000)	Unit Cost Savings ($/bu)	% of Total	Assessment
01	223.3	0.009	4.7	insignificant savings
20	1171.3	0.056	44.4	GST viability questionable
52	97.2	0.052	0.5	insignificant volume

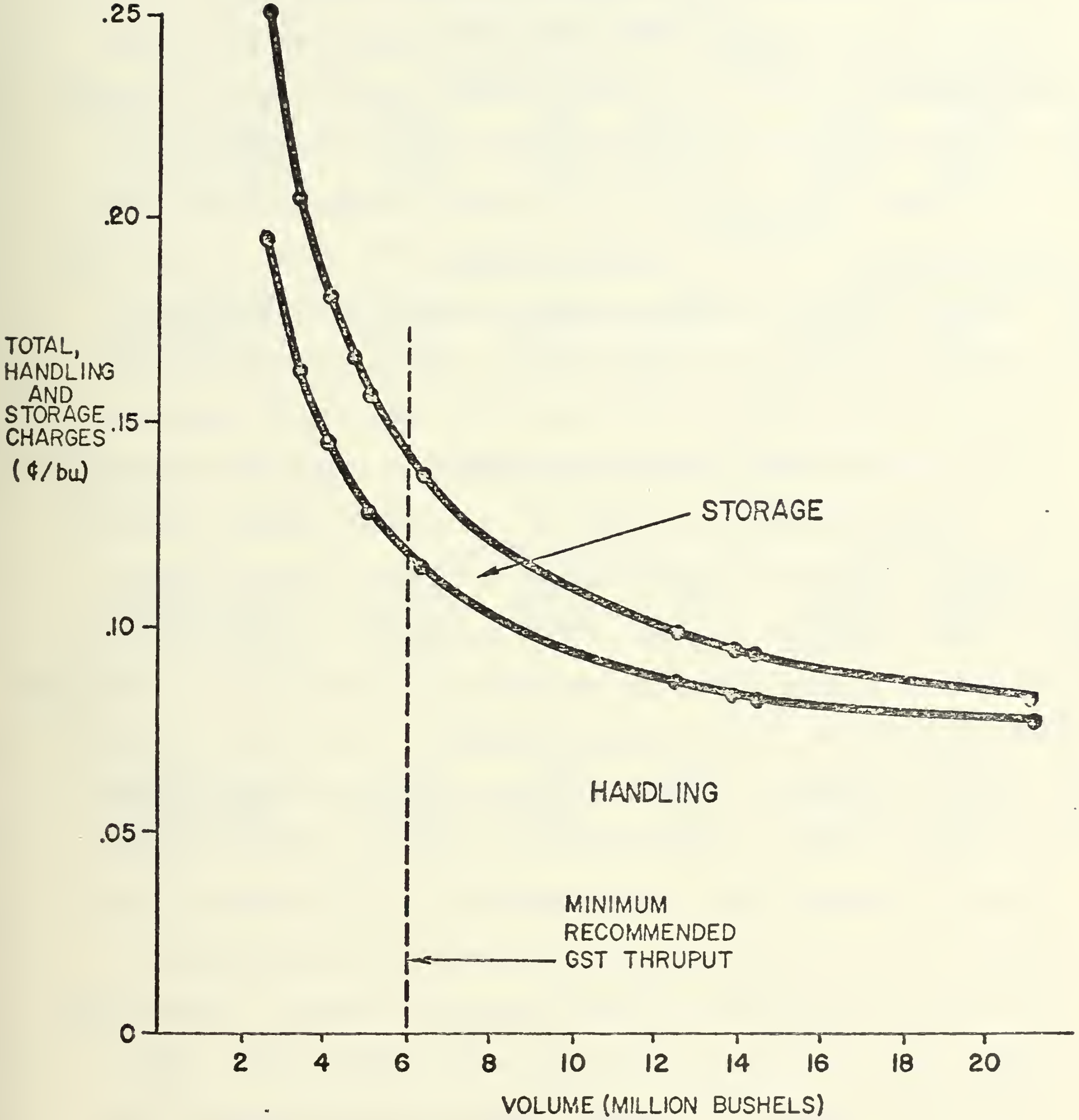
Alternative 3A

Grain Movement Less Costly via GPWs

Subterminal	Bushels (000)	Unit Cost Savings ($/bu)	% of Total	Assessment
01	454.6	0.011	9.6	insignificant savings
09	140.1	0.013	4.0	insignificant savings
20	2276.8	0.060	86.3	GST viability questionable
52	97.2	0.052	0.5	insignificant volume

FIGURE 8

RELATIONSHIP BETWEEN GST THRUPUT AND TOTAL HANDLING AND STORAGE CHARGES FOR A 500,000 BUSHEL FACILITY



Based on a GST capital cost of $4.21 million amortized over a 20 year period at 12 percent for a 500,000 bushel capacity. Storage charges based on a rate of 0.1 cents per bushel per day applied against one half of available capacity (total less working capacity). Handling charges based upon generating sufficient revenues to cover fixed and operating costs plus a profit of ten percent.

Obviously, the greater the throughput, the lower the charges to be assessed against the user. This figure does suggest that GSTs having throughputs below five or six million bushels annually should be avoided, at least in the principal grain producing areas of the State.

Earlier, the concept was introduced that savings in assembly costs (i.e., trucking to the GST) in some instances could offset the additional infrastructure and operating costs associated with multiple GSTs. To test out this possibility, additional GSTs were proposed at Inverness, Great Falls and Chinook to serve the Golden Triangle and at Sprole to serve Northeast Montana, and the revenue and cost computations repeated.1/

The results are given in Table 12. In Northeast Montana, both the charges to the growers and the revenues to carriers increase slightly for both Alternatives 3 and 3A. The resulting change ranges from one to three cents a bushel overall for the privilege of having greater competition. The reason for the increase in cost stems partly from (1) the characteristics of the highway system, (2) the location of GSTs at Macon, Sprole and Homestead which are relatively close together, and (3) the lack of savings in assembly costs. The situation is a little different in the Golden Triangle where the charges to the growers and the revenues to carriers decrease slightly for both Alternatives 3 and 3A. The resulting change ranges from about a half to two cents a bushel overall. Here, assembly cost savings offset higher infrastructure and operating costs.

The above results point to several findings. First, the Golden Triangle and Northeast Montana could support a limited number of additional

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1/ The additional GST proposed at Chinook was subsequently dropped when it became evident there simply wasn't enough grain available locally to make the facility viable. Sprole is located between Poplar and Brockton.

TABLE 12

CHANGE IN REVENUES AND COSTS THROUGH ADDING SUBTERMINALS

Northeast Montana Subterminals

Alternate 3

	Total Revenues & Costs			Unit Revenues & Costs		
Subterminals Only	2 GSTs	3 GSTs	Change	2 GSTs	3 GSTs	Change
Revenues/Charges	$23,483.5	$23,633.5	+ 149.9	$1.240	$1.248	+ 0.008
Cost to Carriers	17,928.6	18,272.9	+ 344.4	0.947	0.965	+ 0.018
Profit to Carriers	5,555.0	5,360.5	- 194.5	0.293	0.283	- 0.010

Alternate 3A

	Total Revenues & Costs			Unit Revenues & Costs		
Subterminals Only	2 GSTs	3 GSTs	Change	2 GSTs	3 GSTs	Change
Revenues/Charges	$23,281.5	$23,789.0	+ 507.5	$1.230	$1.257	+ 0.027
Cost to Carriers	17,928.6	18,272.9	+ 344.4	0.947	0.965	+ 0.018
Profit to Carriers	5,353.0	5,516.1	+ 163.1	0.283	0.292	+ 0.009

Triangle Area Subterminals

Alternate 3

	Total Revenue & Costs			Unit Revenues & Costs		
Subterminals Only	3 GSTs	5 GSTs	Change	3 GSTs	5 GSTs	Change
Revenues/Charges	$47,966.0	$46,988.2	- 977.8	$0.967	$0.947	- 0.020
Cost to Carriers	38,885.3	38,614.8	- 270.5	0.784	0.778	- 0.006
Profit to Carriers	9,080.7	8,373.5	- 707.3	0.183	0.169	- 0.014

Alternate 3A

	Total Revenue & Costs			Unit Revenues & Costs		
Subterminals Only	3 GSTs	5 GSTs	Change	3 GSTs	5 GSTs	Change
Revenues/Charges	$46,622.2	$46,381.2	- 241.0	$0.940	$0.935	- 0.005
Cost to Carriers	38,885.3	38,614.8	- 270.5	0.734	0.778	- 0.006
Profit to Carriers	7,737.0	7,766.5	- 29.5	0.156	0.157	+ 0.001

GSTs without causing any significant change in overall costs or revenues. Second, the maximum number of GSTs feasible statewide would appear to be between 9 and 15. Third, location appears to be quite important in establishing compact tributary areas. The best location is one located at the crossroads of major east-west and north-south routes and lying near the centroid of the GPUs being served. Unfortunately, there are not many locations having these attributes.

E. Would Subterminals be Feasible Without Subterminal Supplied Transport Services?

This study has been based on the principal of minimizing transport costs and hence charges associated with moving westbound wheat from GPUs to West Coast markets. In assembling grain, RCAI has proposed that GSTs provide a transport service to pick-up wheat from growers, rather than to rely solely on grower-provided transport. This service would be provided by trucking firms or owner/operators under contract with the GST.

The advantages of such a service to the GST operator are (1) availability of trucking under GST control, (2) scheduling of inbound movements to coincide with contractural requirements and scheduled unit train movements (i.e., provide the right type of grain at the right time), (3) places greater marketing initiative with the GST, (4) reduces the need for large storage capacity (on-farm storage becomes in effect an extension of GST capacity), and (5) provides incentives to growers located at appreciable distances to market wheat through GSTs rather than through local GPWs.1/

1/ While not the intended function, the availability of trucking capability also improves the ability of a GST to take advantage of "spot" marketing opportunities, particularly those involving small volumes, product characteristics (e.g., protein content), or rapid delivery. These types of markets would also continue to be served by the grain haulers as well as other truckers seeking a backhaul load from both GSTs and GPWs.

For growers, the main advantage is overcoming the geographic bias created by GST location decisions, particularly where the GST distance would be substantially greater than the GPW distance. It also utilizes the greater efficiency of grain trucks on the longer hauls, thus minimizing overall transport costs. Finally, it provides continued employment for at least a portion of the grain haulers displaced by GSTs and unit train service.

Table 13 summarizes local transport changes coincident with the implementation of GSTs. Today, the average (weighted) one-way distance from GPUs to GPWs is 18.8 miles, although the actual distance can range from a few miles to well over a hundred (150 in southeast Montana). For the nine GST tributary areas, the average one-way distance is slightly less or 18.6 miles. In implementing GSTs, this distance increases to 55.8, which is three times the present distance. In the same vein, grain assembly (transport) costs increase from 5.8 to 11.3 percent of total transport charges in implementing GSTs. Hence the legitimacy of grower concerns over local transport.

In determining GST utilization, local transport costs were computed on a mileage basis without regard to how these costs would be distributed. If a GST-supplied transport service was not provided, each grower would have to pay his own cost of transporting grain to the GST in the same fashion as done today to GPWs. Those growers located close to GSTs would incur less cost than those located farther away. Since farm trucks would be predominately utilized (rather than grain trucks), growers located in the fringe areas could very well find the incremental gain from marketing through GSTs not worth the time and effort involved in

TABLE 13

LOCAL TRANSPORT CHANGES COINCIDENT WITH IMPLEMENTATION OF SUBTERMINALS

	01	09	24	26	28	32	37	40	52	ALL GSTs
Present Situation (Base Case)										
Bushels Transported via Farm Truck	5586.3	4397.0	4957.6	16588.5	17049.9	6257.5	16162.8	8846.4	25572.2	109896.7
Average Distance GPU-GPW(mi)	25.6	24.8	20.3	23.4	14.7	17.4	23.7	12.4	14.2	18.8
Distance Range: Up to ____ Miles	80	155	35	95	45	50	105	35	65	-
Wheat Moving Via Subterminals										
GST Thruput (bu)	4721.6	3460.0	4181.1	14410.0	14038.8	5145.4	12560.5	6371.5	21160.0	86048.9
via Farm Truck(bu)	68.1	81.2	1151.0	6810.9	6442.5	769.6	4275.1	2237.1	6630.1	28465.6
via Grain Truck(bu)	4653.5	3378.8	3030.1	7599.1	7596.3	4375.8	8285.4	4134.4	14529.9	57583.3
% by Grain Truck	99	98	73	53	54	85	66	65	69	67
Average Distance										
GPU-GPW(mi)	25.4	24.9	20.3	23.5	14.4	17.7	23.3	12.2	14.1	18.6
GPU-GST(mi)	84.1	87.2	53.5	46.7	42.6	76.2	63.9	46.3	52.9	55.8
Distance Range: Up to ____ Miles	150	180	80	145	85	120	165	105	125	-
Changes in Average Distances: GPU to GST versus GPU to GPW										
GPUs < 35 mi from GST										
Ave Dist to GPWs	9.2	5.8	8.2	19.3	15.2	14.7	19.5	8.0	11.4	15.0
Ave Dist to GST	26.4	25.3	18.7	23.3	27.7	21.5	26.5	21.6	21.9	24.1
Change	+ 17.2	+ 19.5	+ 10.5	+ 4.0	+ 12.5	+ 6.8	+ 7.0	+ 13.6	+ 10.5	+ 8.1
GPUs > 35 mi from GST										
Ave Dist to GPWs	25.6	25.4	24.9	27.3	13.7	18.2	25.3	14.5	15.3	20.2
Ave Dist to GST	84.9	88.7	66.7	67.8	55.3	85.8	83.2	70.2	67.1	72.3
Change w/service	- 25.6	- 25.4	- 24.9	- 27.3	- 13.7	- 18.2	- 25.3	- 14.5	- 15.3	- 20.2
wo/service	+ 59.3	+ 63.3	+ 41.8	+ 40.5	+ 41.6	+ 67.6	+ 57.9	+ 55.7	+ 51.8	+ 52.1
Relative Changes in Farm and Grain Truck Vehicle Miles of Travel										
VMT (one-way)										
GPU-GPW (Base)	282.2	202.7	199.7	796.8	475.7	214.3	688.6	182.9	702.0	3765.9
GPU-GST (FT < 35 mi)	4.2	4.8	50.6	373.4	419.9	38.9	266.6	113.7	341.6	1614.2
GPU-GST (FT > 35 mi)	929.6	705.2	475.5	1212.3	988.4	883.4	1622.0	682.9	2294.0	9795.9
GPU-GST (GT > 35 mi)	388.5	294.7	198.7	506.6	413.1	369.2	677.8	285.4	958.7	4093.7
Impact of GST Sponsored Grain Collection Service on Farm Truck Usage										
With Service: Ratio										
FT VMT/Base VMT	0.01	0.02	0.25	0.47	0.88	0.18	0.39	0.62	0.49	0.43
Total VMT/Base VMT	1.39	1.48	1.25	1.10	1.75	1.90	1.37	2.18	1.85	1.52
Without Service: Ratio										
FT VMT/Base VMT	3.31	3.50	2.63	1.99	2.96	4.30	2.74	4.36	3.75	3.03

All bushels and vehicle miles of travel in thousands.
FT abbreviation for farm truck, VMT for vehicle miles of travel.

transporting grain to the GST, and thus would continue to utilize local GPWs. This of course would reduce the size of GST tributary areas.

If a GST elected to supply a "pick-up" service, it would have to decide whether to (1) offer the service to all growers or only those located beyond a stated distance, (2) charge on the basis of mileage or to levy a uniform or graduated fee, and (3) treat the cost of the transport service as a GST operating expense or to assess it directly against the growers as a service charge off the price paid for the wheat. A uniform fee, which achieves equity among growers vis-a-vis local transport costs, is a form of cross-subsidization. However, it should be recognized that such equity does not exist today, and that the most practical system may be one that equalizes out the added costs associated with the difference in mileage between the GPU-GPW and GPU-GST.

While GSTs are not required to provide a local grain transport service, strong rationale can be made in support of this type of service, especially for GSTs having large tributary areas. One possible scenario for neutralizing distance discrimination caused by GST location decisions, and achieving cost effectiveness by matching vehicle characteristics to the movement involved is described below. Under this scenario, the cost of this service would be assessed uniformly (on a per bushel basis) through a lower price for grain. Growers located more than 35 miles from the GST would receive free pick-up. Presently, the average one-way distance between GPUs and GPWs for these growers is 20.2 miles (range is from 13.7 to 27.3 miles for the nine GST tributary areas). Were this service not provided, the average one-way distance between GPUs and

GSTs would be 72.3 miles (range is from 55.3 to 88.7 miles for the same GST tributary areas), 2 1/2 to four times greater than at present or an average increase of over 50 miles.

As hypothesized, growers located within 35 miles would continue to deliver grain via farm truck. For these growers, the present average one-way distance of 15.0 miles between GPU and GPW would increase to 24.1 miles for the GPU to GST movement. While the 8.1 mile increase is small in comparison with a projected 52.1 mile increase, it does represent added cost. This can be effectively solved were the GSTs to offer a small premium for grower delivered wheat -- a premium large enough to cover out-of-pocket costs associated with farm truck usage for short haul movements. Various other means could be devised for maintaining equity irrespective of location could similarly be devised.[1/]

Table 14 also shows the effect of GST-supplied transport service on vehicle miles of travel between the GPU and the receiving elevator, be it a GPW or GST. Were such a service provided, farm truck usage (for grain hauling only) would drop by an average of 57 percent, (this ranges by GST tributary area from a 12 percent reduction up to nearly a 100 percent reduction) over that occurring with GPWs. While farm truck usage in the aggregate would be cut by over half, total vehicle miles of travel (farm truck plus grain truck) actually increases by an average of 52 percent (again, this ranges from 10 to in excess of 100 percent) over that occurring with GPWs. However, were a GST-supplied transport service not provided, farm truck vehicle miles of travel would more than

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[1/] However, the intent of this study is to focus on overall feasibility and not become deeply emersed in mechanisms for accomplishing this principle.

TABLE 14

IMPORTANCE OF A GST-SPONSORED GRAIN ASSEMBLY SERVICE[1]

	Total (000)	$ per Bushel	Cost Borne By
With GST supplied transport for longer distance assembly movements			
Farm Truck Costs	$ 2,363.9	$ 0.083[2]	Grower
Grain Truck Costs	9,462.0	0.164[3]	GST
Total Assembly Costs	11,825.9	0.137[4]	80% by GSTs 20% by Growers
Without GST supplied transport			
Farm Truck Costs	$12,256.9	$ 0.142[5]	Grower
Increase in Total Assembly Costs	430.3	0.005	Grower
Increase in Farm Truck Costs	9,893.0	0.115	Grower

1/ Computations based on nine Subterminals, handling 86,048,900 bushels of grain under Alternative 3 or 3A. Does not include costs of residual traffic, which would not utilize GSTs.

2/ Based on 28,465,600 bushels moving by farm truck from farm to GST.

3/ Based on 57,583,300 bushels moving by grain truck from farm to GST.

4/ Average cost per bushel.

5/ Average cost assuming all grain moves by farm truck from farm to GST.

triple (again this ranges by GST tributary area from 2 to 4.4 times the potential mileage occurring with GPWs)[1/]. This major increase in local trucking and its potential direct impact upon growers is a very real issue.

The question whether GSTs should be required to provide grain assembly services is partly an economic issue and partly an equity issue, as indicated by Table 14. Were a transport service provided, the average cost to growers would be 8.3 cents per bushel, which could be offset through a premium for direct delivery. Assembly service costs would average 16.4 cents per bushel, which would be borne by all growers through the price offered by the GST. Under such a system, the average assembly cost would be 13.7 cents per bushel of which 80 percent would be borne by GSTs and 20 percent by growers.[2/] If a delivery service was not provided, the average assembly cost would increase to 14.2 cents per bushel -- a relatively insignificant increase. However all of this cost would be borne by the grower, and would vary appreciably depending upon grower location vis-a-vis the GST.

Thus, the roughly five percent increase in local transport costs caused by substituting farm trucks for grain trucks (GSTs elect not to supply a transport service) does not appear large enough to affect GST viability, although it could reduce the size of the tributary area. What it does is to accentuate distance discrimination caused by GST location decisions largely beyond grower control.

[1/] This assumes continued utilization of two axle and three axle single unit trucks having carrying capacities ranging from 350 to 500 bushels. If faced with appreciably longer farm-to-market hauling distances, many growers would probably invest in used tractor-trailer rigs capable of hauling 800 bushels or more, thus reducing the projected increase in vehicle miles of travel.

[2/] The latter assumes no premium for direct delivery, which is instituted, would reduce the portion borne by the grower.

The important point is that the equity problem can only be solved by GSTs providing a transport service to assemble grain, or monetary equivalents thereto.

F. What Impact Would Subterminals Have on the State's Highway System?

In the previous section, numbers were presented giving the expected change in local truck miles of travel associated with delivering grain to a GST in place of a GPW, both with and without a GST-supported assembly service. The projected overall increase is, however, offset by an even larger reduction in line haul trucking to river terminals and west coast markets. Table 15 summarizes these changes. In 1979, farm and grain trucks transporting grain to GPWs, river terminals, and west coast markets were estimated to have traveled some 27.1 million miles of travel of which 17.6 million miles occurred over the state and local highway systems in Montana.[1/] Under Alternatives 3 and 3A, truck travel is estimated to decrease to 6.7 or 11.1 million miles annually within Montana, depending upon whether GSTs offer a grain assembly service or not.[2/] This represents an approximate 62 and 37 percent reduction from base case truck miles of travel associated with hauling westbound wheat.

Such reductions in mileage occur primarily on the principal grain hauling routes, such as Interstate 90, US 2, and Montana 200. Farm and grain truck volumes will increase on highway segments in the general vicinity of GSTs. This effect is illustrated in Figures 9 and 10, which show present and projected _annual_ grain truck volumes on routes

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[1/] Does not include backhaul mileage. Farm haul trucks were presumed to be empty and grain trucks partially utilized for other commodities.

[2/] Some of this decrease is probably already occurring as a consequence of diversion to rail brought about by the lower single car rates.

TABLE 15

CHANGES IN ANNUAL TRUCK VEHICLE MILES OF TRAVEL

	Truck Vehicle Miles of Travel (000)		
	Within Montana	Out-of-State	Total VMT
Base Case			
Farm Trucks to GPWs	4,854.9	-	4,854.9
Grain Trucks in Line Haul Service to Markets, River Terminals	12,748.6	9,509.3	22,257.9
Subtotal	17,603.5	9,509.3	27,112.8
Alternatives 3 and 3A (with a GST-Supplied Transport Service)[1]			
Farm Trucks to GSTs	607.5	-	607.5
Grain Trucks in Collector Service to GSTs	3,134.1	-	3,134.1
Farm Trucks to GPWs (Residual)	1,079.3	-	1,079.3
Grain Trucks in Line Haul Services to Markets, River Terminals (Residual)	1,913.8	1,427.3	3,341.1
Subtotal	6,734.7	1,427.3	8,162.0
Alternatives 3 and 3A (without a GST-Supplied Transport Service)[1]			
Farm Trucks to GSTs	8,107.1	-	8,107.1
Farm Trucks to GPWs (Residual)	1,079.3	-	1,079.3
Grain Trucks in Line Haul Services to Markets, River Terminals (Residual)	1,913.8	1,427.3	3,341.1
Subtotal	11,100.2	1,427.3	12,527.5
Change in Truck Vehicle Miles of Travel			
With GST-Supplied Service	- 10,868.8	- 8,082.0	- 18,950.8
Percent Change	- 62%	- 85%	- 70%
Without GST-Supplied Service	- 6,503.3	- 8,082.0	- 14,585.3
Percent Change	- 37%	- 85%	- 54%

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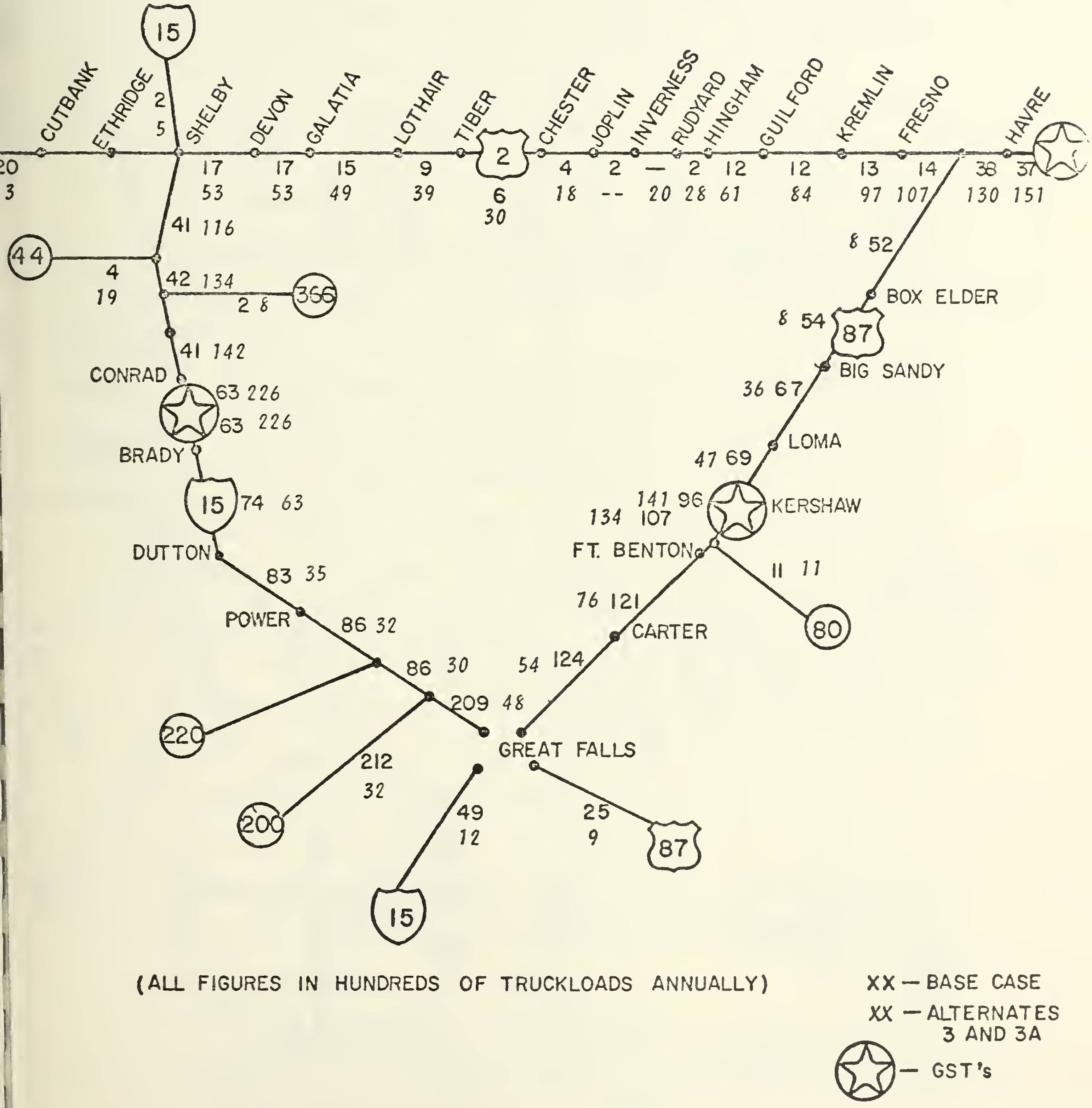
[1] Based on ten GSTs. Numbers shown will be slightly higher for nine GSTs, with somewhat less change in truck vehicle miles of travel.

FIGURE 9

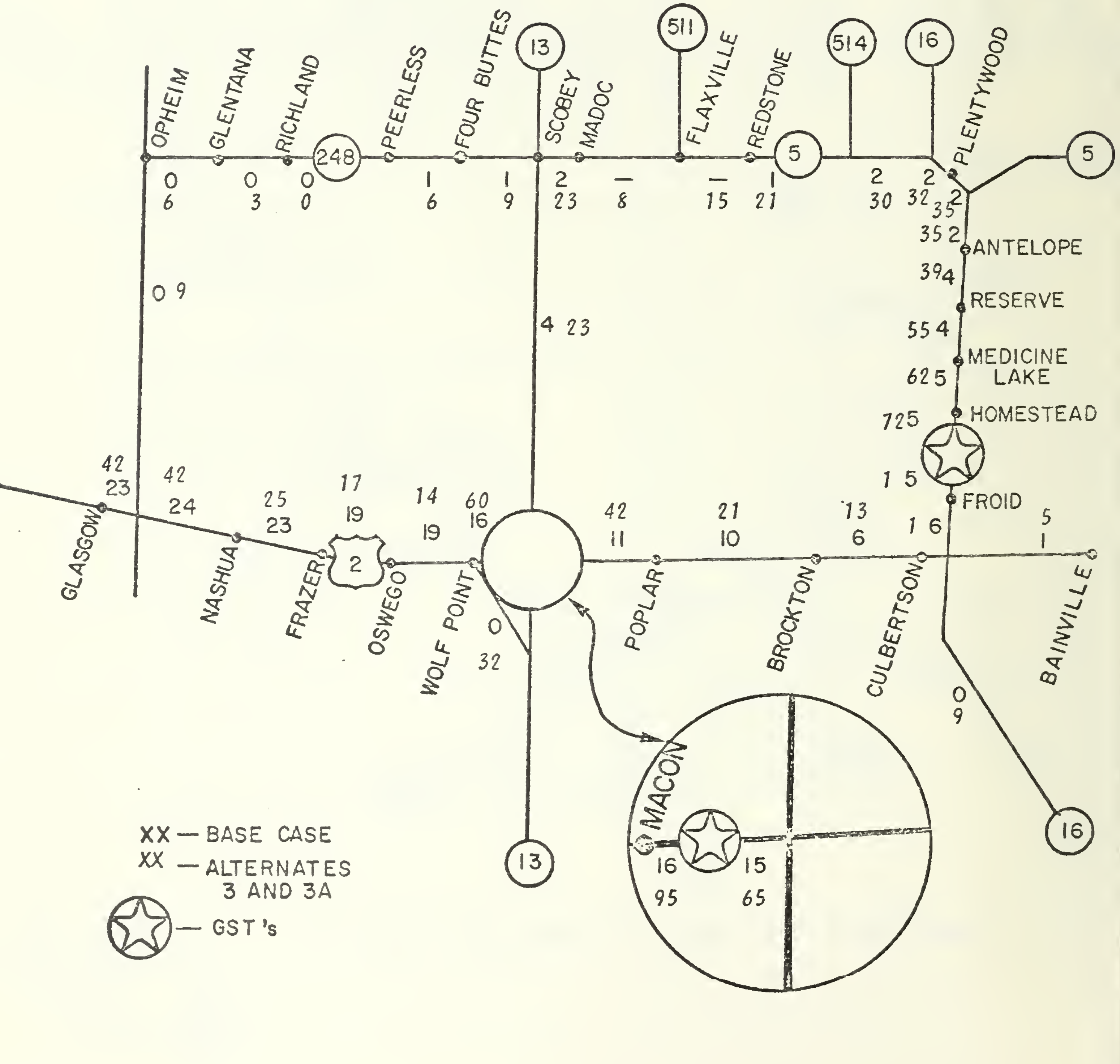
ESTIMATED GRAIN TRUCK VOLUMES-GOLDEN TRIANGLE



(ALL FIGURES IN HUNDREDS OF TRUCKLOADS ANNUALLY)

FIGURE 10

ESTIMATED GRAIN TRUCK VOLUMES–NORTHEAST MONTANA



(ALL FIGURES IN HUNDREDS OF TRUCKLOADS ANNUALLY) bordering the Golden Triangle and in Northeastern Montana. While the increases shown may appear to be sizable, they are not particularly large when expressed on a daily or hourly basis.[1] The major increases would occur on highways which generally have excess capacity.

Changes in truck volumes per se do not directly reflect impacts on the pavement and substructure. Consequently, both present truck volumes and the estimated change in farm and grain truck volumes have been converted to equivalent annual load applications (EALA), which places the impact of vehicles having different weights and wheel and axle configurations on a uniform basis.

The total loadings anticipated under Alternatives 3 and 3A were then compared with those occurring under the base case on a segment-by-segment basis to determine absolute and relative impact. Figure 11 shows the results of this comparison for selected highway segments in Montana. As can be seen, pavement loadings would generally decrease. Figure 12 presents similar information for segments located adjacent to higher volume GSTs, although here pavement loadings tend to go up somewhat. On an overall statewide basis, the average EALA decreases from 44.4 with the base case to 39.7 with Alternatives 3 and 3A, an 11 percent decrease.

Thus, GSTs exert generally positive impacts which occur over most of the State highway system. While truck volumes and loadings often do increase in the vicinity of GSTs, these effects are localized and do not appear large enough to significantly reduce present levels of service or greatly hasten pavement deterioration.

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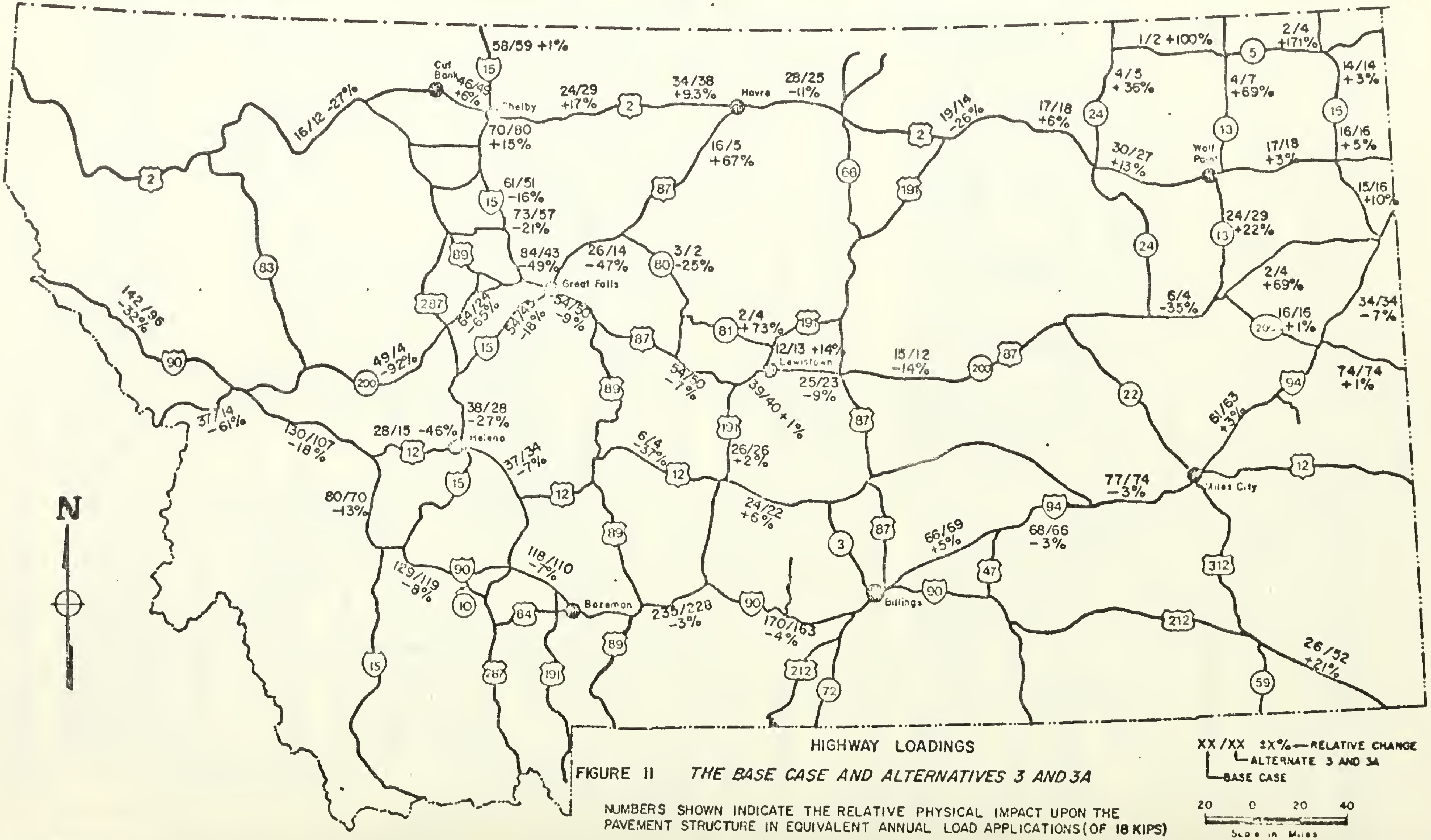
[1] For example, an annual volume of 7200 vehicles roughly translates into 24 loaded vehicles per day or a total movement of 48 vehicles per day, which is roughly six an hour. Such volumes do not appreciably affect the level of service of a highway.



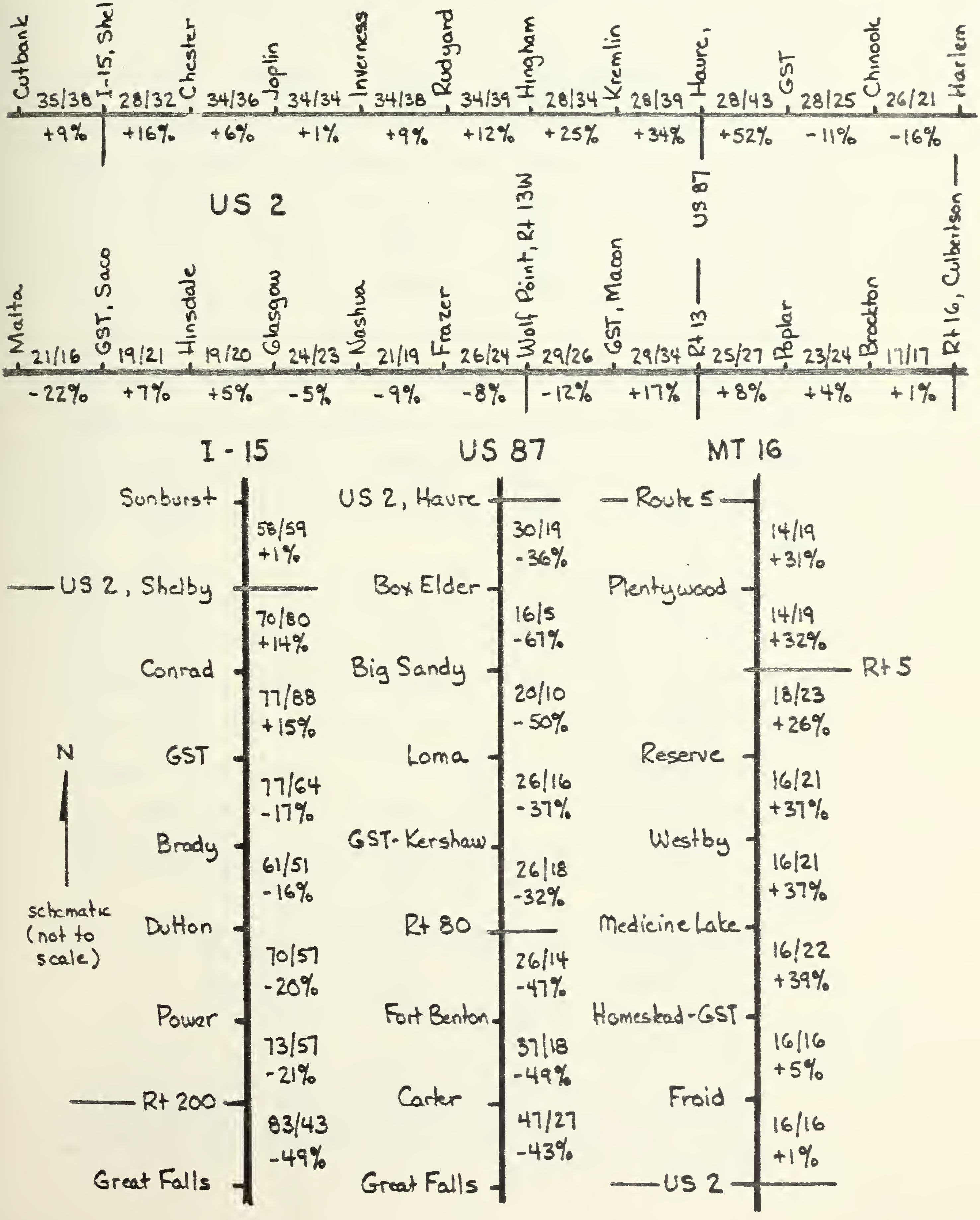
HIGHWAY LOADINGS

FIGURE 11 *THE BASE CASE AND ALTERNATIVES 3 AND 3A*

NUMBERS SHOWN INDICATE THE RELATIVE PHYSICAL IMPACT UPON THE PAVEMENT STRUCTURE IN EQUIVALENT ANNUAL LOAD APPLICATIONS (OF 18 KIPS)

Figure 12 - Highway Loadings in the Vicinity of Grain Subterminals

numbers shown indicate the relative physical impact upon the pavement structure in equivalent annual load applications (of 18 kips)



G. Overall Assessment

The overall results of the grain subterminal study substantiate what Montana officials have privately suspected for some time -- that GSTs are feasible as a replacement for, but not as a supplement to existing GPWs.

Table 16 presents "final" transport system revenues and costs, based on a system of nine subterminals statewide. Relatively little overall change has occurred from previous revenue and cost figures (see Table 10) in cutting back from ten to nine subterminals. As would be expected, GST revenues and costs are down a bit, whereas residual costs and revenues are up a little. Carrier profitability is down by a small amount.

Thus on a statewide basis, implementation of the nine GSTs could save growers up to $11.7 or $12.6 million annually under Alternatives 3 or 3A, respectively.[1/] This equates to a unit savings of 14.2 and 15.3 cents per bushel, respectively, for the subterminal user and 10.6 and 11.5 cents per bushel, respectively, overall. Carrier and elevator costs would concurrently decrease by $20.1 million or 18.3 cents per bushel, annually, which includes the identified potential savings to growers.

Table 17 summarizes carrier and elevator revenues and costs for Alternatives 3 and 3A.

[1/] This does not include the $10.4 million or 13.9 cents per bushel reduction in charges already received by growers as a consequence of the December 1, 1980 reduction in single car rates. In addition, there is no guarantee that the savings indicated would actually be passed back to the grower.

TABLE 16

TRANSPORT SYSTEM REVENUES AND COSTS FOR ALTERNATIVES 3 AND 3A (FINAL)

	Alternative 3[1]		Alternative 3A[2]	
	Total (000)	per Bushel	Total (000)	per Bushel
Subterminals Only[3]				
Revenues/Charges	$ 92,217.6	$ 1.072	$ 91,289.4	$ 1.061
Cost to Carriers	73,746.2	0.857	73,746.2	0.857
Profit to Carriers	18,471.4	0.215	17,543.2	0.204
With Residual[4]				
Revenues/Charges	121,712.1	1.108	120,784.0	1.099
Cost to Carriers	98,930.6	0.900	98,930.6	0.900
Profit to Carriers	22,781.5	0.207	21,853.4	0.199
Difference from Base Case[4]				
Revenues/Charges	- 11,690.3	- 0.106	- 12,618.5	- 0.115
Cost to Carriers	- 20,135.7	- 0.183	- 20,135.7	- 0.183
Profit to Carriers	+ 8,445.3	+ 0.077	+ 7,517.2	+ 0.068

1/ Fixed handling charge.
2/ Variable handling charge.
3/ Based on 86,048,900 bushels (9 subterminals).
4/ Based on 109,896,700 bushels.

TABLE 17

CARRIER AND ELEVATOR REVENUES AND COSTS FOR ALTERNATIVES 3 AND 3A

(all figures in thousands)

	Revenue	Cost	Net Profit	Percent Profit
Present (Base Case)[1]				
Rail	$ 74,432.2	$ 60,689.8	$ 13,742.4	22.6
Truck	28,550.2	29,816.7	- 1,262.5	-4.2
Barge	5,142.4	5,142.4	-	-
GPWs	18,014.8	16,154.5	1,860.3	11.5
GSTs	-	-	-	-
Farm Trucks	7,262.9	7,262.9	-	-
Subterminals Only[2]				
Rail	69,424.2	52,793.6	16,630.6	31.5
Truck	9,462.0[3]	9,462.0[3]	-	-
Barge	-	-	-	-
GPWs	-	-	-	-
GSTs	10,967.5[4]	9,126.7	1,840.8[5]	20.2[6]
Farm Trucks	2,363.9	2,363.9	-	-
With Residual[1]				
Rail	86,189.9	65,224.4	20,965.5	32.1
Truck	15,439.1[7]	15,874.6[7]	- 435.5	- 2.5
Barge	951.8	951.8	-	-
GPWs	4,161.0	3,750.2	410.8	11.0
GSTs	10,967.5	9,126.7	1,840.8	20.1
Farm Trucks	4,003.0[8]	4,003.0[8]	-	-
Difference from Base Case[1]				
Rail	+ 11,757.7	+ 4,534.7	+7,223.1	
Truck	- 13,111.2[9]	-13,942.1[9]	+ 830.9	
Barge	- 4,190.6	- 4,190.6	-	
GPWs	- 13,853.8	-12,404.4	-1,449.4	
GSTs	+ 10,967.5	+ 9,126.7	+1,840.8	
Farm Trucks	- 3,260.0[10]	- 3,260.0[10]	-	

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[1] Based on 109,896,700 bushels.

[2] Based on 86,048,900 bushels (9 subterminals.)

[3] With GST-supplied transport service.

[4] Computed for Alt.3. Corresponding value for Alt.3A is $10,039.4.

[5] Computed for Alt.3. Corresponding value for Alt.3A is $912.6.

[6] Computed for Alt.3. Corresponding value for Alt.3A is 10.0.

[7] $5,977.1 revenues and $6,412.6 cost without GST-supplied transport service.

[8] $13,895.3 without GST-supplied transport service.

[9] -$22,573.2 revenues and - $23,404.1 cost without GST-supplied transport service.

[10] +$6,632.3 without GST-supplied transport service.

As would be expected, the distributional effects are quite variable, as discussed below:

- Railroads. Railroad revenues are projected to increase from \$74.4 to \$86.2 million and costs from \$60.7 to 65.2 million. The large increase in railroad (BN) revenues and lesser increase in costs is attributable to (1) diverting present truck and truck/barge traffic to rail and (2) substituting unit trains for single car rail services. As indicated, the BN stands to substantially increase the profitability of its grain transport operations in Montana. The figures shown do not include the cost savings stemming from (1) cutbacks in the frequency of local freights, (2) decreased size of the car fleet, and (3) potential elimination of branchlines no longer required.1/ Thus the potential profitability is even larger.

- Motor Carriers. Much depends upon whether GSTs contract out grain assembly services to grain haulers or leave delivery entirely in the hands of growers. Under the former, motor carrier revenues and costs are projected to decrease by nearly one half, or from \$28.6 to \$15.4 million and from \$29.8 to \$15.9 million respectively.2/ Under the latter situation, respectively. Introduction of GSTs and unit trains obviously cuts deeply into the line haul business presently enjoyed by motor carriers, as evidenced by the reduction in volume from 36.5 to 7.3 million bushels. Yet were GSTs to contract out grain assembly services as described previously, the potential market amounts to 60.1 million bushels. Obviously, the average haul distance decreases significantly with the change of function.

- Barge Operators. Barge and river terminal revenues and costs are projected to decrease from \$5.1 million to \$1.0 million. While this seems to be a major loss, barge and river terminal operators derive a large portion of their business from wheat, barley, and lentils produced in the "Paloose" section of northern Idaho and eastern Washington.

- GPWs and GSTs. The projected decrease in revenues and costs for GPWs (from \$18.0 to \$4.2 million and from \$16.2 to \$3.8 million, respectively) is largely offset by the revenues and costs of GPWs, which amount to \$11.0 and \$9.1 million, respectively. A sizeable contraction in the number of GPWs remaining in business can be expected, as previously discussed.

1/ Montana does not have that many branchlines for which the traffic is predominately wheat and barley. Savings from branchline abandonments are often delayed on account of local opposition and the administration difficulty typically encountered in securing a certificate of public convenience and necessity.

2/ Motor carriers will find it difficult to make much of a profit, since they typically charge a few cents a bushel less than rail rates. Much depends upon the efficiency of the particular carrier, his anility to obtain steady utilization of his equipment, and the profitability of the markets served.

TABLE 18

SUBTERMINAL TOTAL REVENUES AND COSTS (ALTERNATIVES 3 AND 3A)
(ALL FIGURES IN THOUSANDS OF DOLLARS)

ALTERNATIVE 3	01	09	24	26	28	32	37	40	52
Subterminals Only 1/									
Revenues/Charges	5846	4617	4280	13657	14124	6025	15473	8011	20186
Cost to Carriers	4549	3715	3830	11762	11182	4838	11722	6206	15941
Profit to Carriers	1297	901	451	1895	2941	1187	3751	1804	4245
with Residual 2/									
Revenues/Charges	6973	6000	5196	16026	17583	7516	20529	11409	25020
Cost to Carriers	5544	4806	4661	14019	13953	6024	15718	8882	20025
Profit to Carriers	1429	1194	535	2008	3630	1493	4812	2527	4996
difference from Base Case 2/									
Revenues/Charges	- 211	- 639	- 666	-2005	-1767	- 806	-2250	- 919	-2724
Cost to Carriers	-1065	- 727	- 950	-3727	-2871	-1090	-3525	-1485	-4983
Profit to Carriers	+ 854	+ 88	+ 284	+1723	+1103	+ 284	+1275	+ 566	+1588
Add'l Savings from BN Rate Reduction	272	540	257	709	1726	1097	2837	1422	1373

ALTERNATIVE 3A	01	09	24	26	28	32	37	40	52
Subterminals Only 1/									
Revenues/Charges	5985	4815	4445	13308	13799	6141	15212	8070	19515
Cost to Carriers	4549	3715	3830	11762	11182	4838	11722	6206	15941
Profit to Carriers	1435	1099	616	1546	2617	1303	3489	1864	3574
with Residual 2/									
Revenues/Charges	7112	6198	5362	15677	17259	7632	20268	11469	24350
Cost to Carriers	5544	4806	4661	14019	13953	6024	15718	8882	20025
Profit to Carriers	1568	1392	700	1659	3306	1608	4550	2587	4325
difference from Base Case 2/									
Revenues/Charges	- 72	- 441	- 501	-2354	-2092	- 690	-2512	- 859	-3395
Cost to Carriers	-1065	- 727	- 950	-3727	-2871	-1090	-3525	-1485	-4983
Profit to Carriers	+ 993	+ 286	+ 449	+1374	+ 779	+ 400	+1014	+ 625	+1588
Additional Savings from BN Rate Reduction	272	540	257	709	1726	1097	2837	1422	1373

1/ Based on 88,687,400 bushels (all 10 subterminals.)
2/ Based on 109,896,700 bushels.

TABLE 19

SUBTERMINAL UNIT REVENUES AND COSTS (ALTERNATIVES 3 AND 3A)
(ALL FIGURES IN DOLLARS PER BUSHEL)

ALTERNATIVE 3

	01	09	24	26	28	32	37	40	52
Subterminals Only[1]									
Revenues/Charges	1.238	1.334	1.024	0.948	1.006	1.171	1.232	1.257	0.954
Cost to Carriers	0.964	1.074	0.916	0.816	0.797	0.940	0.933	0.974	0.753
Profit to Carriers	0.275	0.261	0.108	0.132	0.210	0.231	0.299	0.283	0.201
with Residual[2]									
Revenues/Charges	1.248	1.365	1.048	0.966	1.031	1.201	1.270	1.290	0.978
Cost to Carriers	0.992	1.093	0.940	0.845	0.818	0.963	0.972	1.004	0.783
Profit to Carriers	0.256	0.272	0.108	0.121	0.213	0.239	0.298	0.286	0.195
difference from Base Case 2/									
Revenues/Charges	-0.038	-0.145	-0.134	-0.121	-0.104	-0.129	-0.139	-0.104	-0.107
Cost to Carriers	-0.191	-0.165	-0.192	-0.225	-0.168	-0.174	-0.218	-0.168	-0.195
Profit to Carriers	+0.153	+0.020	+0.057	+0.104	+0.065	+0.045	+0.079	+0.064	+0.062
Add'l Savings from BN Rate Reduction	0.099	0.163	0.090	0.091	0.120	0.208	0.203	0.178	0.097

ALTERNATIVE 3A

	01	09	24	26	28	32	37	40	52
Subterminals Only[1]									
Revenues/Charges	1.268	1.392	1.063	0.924	0.983	1.193	1.211	1.267	0.922
Cost to Carriers	0.964	1.074	0.916	0.816	0.797	0.940	0.933	0.974	0.753
Profit to Carriers	0.304	0.318	0.147	0.107	0.186	0.253	0.278	0.293	0.169
with Residual[2]									
Revenues/Charges	1.273	1.410	1.081	0.945	1.012	1.220	1.254	1.296	0.952
Cost to Carriers	0.992	1.093	0.940	0.845	0.818	0.963	0.972	1.004	0.783
Profit to Carriers	0.281	0.317	0.141	0.100	0.194	0.257	0.282	0.292	0.169
difference from Base Case 2/									
Revenues/Charges	-0.013	-0.100	-0.101	-0.142	-0.123	-0.110	-0.155	-0.097	-0.133
Cost to Carriers	-0.191	-0.165	-0.192	-0.225	-0.168	-0.174	-0.218	-0.168	-0.195
Profit to Carriers	+0.178	+0.065	+0.091	+0.083	+0.046	+0.064	+0.063	+0.071	+0.062
Add'l Savings from BN Rate Reduction	0.099	0.163	0.090	0.091	0.120	0.208	0.203	0.178	0.097

1/ Based on 88,687,400 bushels (all 10 subterminals.)
2/ Based on 109,896,700 bushels.

- Farm Trucks. Again, much depends upon whether GSTs contract out grain assembly services to grain haulers or lease delivery entirely in the hands of growers. Under the former, farm truck costs are expected to decrease from $7.3 to $4.0 million. However, if growers must provide their own transports, costs are projected to increase from $7.3 to $13.9 million.

While GST revenues and costs on a statewide basis are obviously of interest, what really matters is the viability of individual GSTs. Tables 18 and 19 present GST revenues and costs both in the form of totals and as a unit revenue charge or cost per bushel. In all cases, both the revenues/charges and costs are down from the base case. Under a uniform handling charge operating scenario (Alternative 3), GSTs 01, 09, 24, and 32 are projected to operate at a loss, which is offset by the profits from the other five GSTs. Thus this alternative is only applicable if all GSTs were operated by a single entity where cross-subsidation was used to maintain equity for the growers. Alternative 3A is based on a variable handling charge scenario where each GST is expected to stand on its own. Hence the difference in revenues/charges where the GSTs having the higher volumes can charge less, and hence the potential savings to growers are greater. However as has been stated before, no guarantee can be made that such savings will indeed be passed back to the grower.

Because of economies of scale, GSTs are more efficient and do lower the cost of grain transport to the west coast. Are sufficient incentives present to bring about GSTs? And if so, will it be of benefit to Montana? Of the six principal parties affected by GSTs (railroads, motor carriers, barge/river elevators, GPWs, GSTs, and the growers), the main beneficiaries are the railroads, the GST operator, and the grower, as indicated below in Table 20 .

TABLE 20

DISTRIBUTION OF COST SAVINGS

Carrier/Elevator	Percent of Cost Savings Alt. 3	Alt. 3A
Railroads	+ 35.9%	+ 35.9%
Motor Carriers	+ 4.1%	+ 4.1%
Barge/River Terminals	-	-
GPWs	- 7.2%	- 7.2%
GSTs	+ 9.1%	+ 4.5%
Growers	+ 58.1%	+ 62.7%

The computations made indicate that the GSTs and growers combined will receive roughly two-thirds of the transport cost savings and railroads slightly over one-third, once GSTs are fully implemented. The latter, however, does not include any profits stemming from increased car fleet utilization, decreased local service to remaining GPWs, and eventual abandonment of redundant "grain" branchlines. Thus, the eventual profit split is expected to be roughly 50-50.

Note that the distribution of cost savings for GSTs and growers has been combined by brackets. The reason for this is that the final distribution of cost savings depends upon who builds and implements GSTs. Present interest in such facilities by the private sector is based on the expectation of being able to retain at least a sizeable portion of the savings shown as being passed on to growers.

It should be recognized that Table 20 is simply an estimate of the distribution of benefits as things now stand. Whether this represents a fair distribution of the potential benefits is a judgement beyond the scope of the study. It is well to recognize that this distribution has been bequeathed by the unilateral action of the BN in instituting volume rates on December 1, 1980, rather than through any negotiation process.[1/] Recent actions by the private sector demonstrate that sufficient incentives are present to implement GSTs, at least in the Golden Triangle and in Northeast Montana, but that the motivating factors may be more enlarging one's market share (at the expense of competitors) and self-survival rather than more efficient transport. If left to the mercy of private enterprise, the grower frankly is in rather vulnerable and precarious position, and probably will benefit only modestly from the implementation of GSTs. It is important to recognize that GSTs will be of benefit to Montana only if a major portion of the benefits are retained within the state -- that is, acrue to growers and locally-owned GSTs rather than to the transport companies or GSTs owned by outside interests.

[1/] It should be recognized that any further volume rate concessions will require changes in related requirements (e.g., loading time) that will result in equal or greater cost savings to the railroad.

APPENDIX

THE GRAIN TRANSPORT COSTING MODEL

The quantitative procedures used in this study are built around micro-economic analysis techniques using the rather detailed, almost unique information available on GPU production, GPW throughputs, and markets for wheat. It is based on the principle that the grower will choose the least cost transport so as to maximize the income received (the major grain markets essentially establish wheat prices).

Conceptually, the methodology is quite simple and straightforward. For each GPU-GPW-market commodity movement or "flow", the procedure involves systematically comparing costs and revenues associated with two (or more) routings between points of commonality (i.e., the producers at the origin end and the markets or market gateways at the destination end). The first routing, the null situation or base case, consists of small volume flows moving from GPUs to GPWs to markets by up to five mode/destination combinations involving either truck or single car rail transport. The second routing, the proposed GST alternative(s), consists of truck movements to GSTs (either direct from GPUs or via GPWs) followed by volume shipments from GSTs to markets using unit trains. The second routing will never totally displace the first, since there will always be some traffic which will continue to move by truck and single car rail (termed residual traffic in this study). At each stage, information on the cost of providing the transport and revenues derived therefrom by the transport company (charges or rates to the purchaser of the transport service) is developed and accumulated.

The Grain Transport Costing Model (GTCM) itself is nothing more than a systematic procedure for making a large number of revenue and cost calculations which, in the aggregate, determine the economic feasibility of GSTs in Montana.

The GTCM is a special purpose model designed solely for the rather unusual situation of a single agricultural commodity (wheat) moving to essentially a single market (deepwater ports handling export wheat located in and around Portland, OR). Dealing with a cyclically-produced commodity, and a more or less temporally uniform demand, the GTCM does not have to become emeshed with inventory costs and other factors typical of physical distribution models. Having but one major destination eliminates any need to distribute traffic. Pacific North Coast ports handle much of the food and feed grains sold to Pacific rim countries, of which Montana-produced wheat represents only one-third of the total wheat handled. Demand for grain is a function of world market needs, which mirror agricultural successes or failures outside of the United States. Given the uncertanties involved in predicting future wheat sales, as well as the size of the wheat harvest in Montana (which itself can vary extensively on account of weather conditions), no attempt has been made to project future market demand or grain flows, although it has in recent years increased by several percent per year.

The model is itself a blend of quantitative assessments and professional judgments. There are times when the latter are preferable to the former; the system devised for handling the question of mode split or market shares between GSTs and unit trains versus GPWs and conventional rail and truck service is a good example of a situation where expert opinions are probably more useful (and probably more reliable) than the results obtained from rigid objective procedures. Another example is the cut-and-dry process utilized in estimating the number and location of GSTs. While a self-optimizing process could have been designed for this purpose, it would have cost more without any corresponding guarantee of producing better results. Optimizing models cannot discriminate between good and bad sites (i.e., in terms of their physical suitability for GSTs) nor can they be truly reflective of such non-quantifiable factors as long-standing commercial trading relationships.

The GTCM was designed for just one purpose -- determing the economic feasibility of GSTs as applied to Montana. The end product was never intended to be the optimum or even a location plan for GSTs in Montana. Likewise, the model was not intended to mathematically replicate the grain merchandising system in Montana. The progression of grain from Montana farms to final destinations involves numerous and varied business transactions, some of which involve transport and some of which do not. The GTCM makes no pretense of attempting to replicate the intricacies of the grain marketing business, but rather focuses solely on the cost of and revenues derived from transporting grain. It was felt that supply/demand/price relationships and a profit motivation on the part of grain merchandisers will always be present, whether there are GSTs or not. Hence, it was not considered necessary to make assumptions concerning (1) world or major terminal prices for wheat, (2) the type or number of intermediate business transactions involving actual or future grain ownership, and (3) the degree to which present marketing practices and institutions would change with the advent of GSTs. (If anything, it was felt that merchandising costs would be reduced with GSTs as a consequence of their potentially greater market strength in dealing with the major grain companies.)

The remainder of this Appendix is divided into six sections. Section A describes, in general terms, the procedures used to determine GPU-GPW-market wheat movements. Section B summarizes the various transport and elevator charges and rates used in the GTCM. Section C similarly summarizes the unit costs developed for this study. Appreciable time and effort was spent on preparing, and then cross-checking, unit charges/rates and costs -- largely due to the pivotal role played by such information in the GTCM. Section D summarizes, in equation form, the calculations made to determine economic feasibility of GSTs. Section E describes the highway and rail networks developed primarily to determine the specific impacts of GSTs on the respective transportation systems. Section F describes the highway impact calculations made as part of this study. Finally, Section G presents GST specifications.

A. Estimating Grain Flows Through Public Warehouses

This section describes, in general terms, the procedure used to devise grain flows through GPWs. No single data source was complete either in terms of containing all GPWs or reflecting total yearly throughput. Since the amount of grain moving through individual elevators and the system on the statewide level are crucial to establishing the economic feasibility of GSTs, it was necessary to reconcile differences among the various sources to arrive at more or less accurate numbers for 1979 wheat and barley throughputs, as well as the distribution between rail and truck modes to various destinations.

The methodology fashioned to accomplish this task exploited the positive attributes of each of the available data sources, relying upon reasoning, professional judgement, and knowledge of grain operations in Montana. The discussion of the methodology presented below sets forth the ground rules followed and the instances where judgement was required. The individual work sheets synthesizing the data for each elevator are contained in a confidential document in the possession of the Rail Planning Unit of the Montana Department of Highways.

In all, there are eight possible combinations of data source availability for grain movements for GPWs in 1979:

(1) Grain Movement System, Wheat Commission, and Special Survey.
(2) Grain Movement System and Wheat Commission.
(3) Grain Movement System and Special Survey.
(4) Wheat Commission and Special Survey.
(5) Grain Movement System.

(6) Wheat Commission.

(7) Special Survey.

(8) No data directly available.

In Table 1 , the number of GPW's corresponding to each of these data availability combinations is presented. It can be seen that for 89.6% of the GPWs, two or more sources of data were available.

1. Three Sources of Data

Data was available from the three primary sources for 141 public warehouses. If data were available from these sources, the Grain Movement System, the Wheat Commission, and the Special Survey for a single elevator the following procedure was followed:

- If the total throughputs are all within ± 10% of each other, the highest throughput figure was used. The percentage distribution between modes and among destinations was obtained from the GMS. The modal split between rail/truck was checked for the GMS and the Special Survey to insure consistancy.
- If the total throughputs were not within ± 10% of each other, the causes for this discrepancy were pursued further. In most instances, GMS figures were lower than the WC or the Special Survey due to non-reporting in some months. For these situations, the highest reported figure was used as well as the percentages from the GMS in the manner described above.
- If the GPW was located on the Milwaukee, then the amount of grain reported shipped by rail in the GMS and the Special Survey was compared with data supplied by the Milwaukee Road to check for consistancy. If any discrepancies were noted, figures and percentages were normalized to reflect the Milwaukee data.

This procedure, with modifications and exceptions noted in Sub-sections 2 and 3, was used as the basis for establishing all elevator throughputs.

TABLE 1

DATA AVAILABILITY FOR 1979 GRAIN SHIPMENTS BY SOURCE

Source[1]	Number of Elevators	% of Elevators	Bushels of Wheat	% of Bushels
GMS, WC, S	139	60.4	69,344,000	57.9
GMS, WC	48	20.9	23,713,000	19.8
GMS, S	8	3.5	4,910,000	4.0
WC, S	11	4.8	4,855,000	4.1
GMS	5	2.2	1,374,000	1.1
WC	9	3.9	12,695,000	10.6
S	3	1.3	1,557,000	1.3
None[2]	7	3.0	1,317,000	1.1
TOTAL	230	100.0	119,765,000	100.0

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[1] The abbreviations used are as follows:

GMS - Grain Movement System
WC - Montana Wheat Research and Marketing Committee
S - Special Survey

[2] Data on grain throughputs for these GPWs were not directly available from the three primary sources: GMS, WC and S. Throughputs for these facilities were induced or derived in the manner described in Sub-section 4.

2. Any Two Sources of Data

For 65 GPWs, data was available from only two primary sources of data for 1979. These combinations were: (1) Grain Movement System and Wheat Commission (46 GPWs); (2) Grain Movement System and Special Survey (8 GPWs); and (3) Wheat Commission and Special Survey (11 GPWs). Each of these situations are described below.

GMS and Wheat Commission: GMS proportions for 1979 were used to derive Wheat Commission throughputs for each facility that did not report individually for the Wheat Commission. Once throughputs were initially established, the procedure described in Sub-section 1 was used; except that, in the absence of Special Survey results, the GMS modal split could not be verified.

In general, Wheat Commission throughputs were found to be higher than those reported in the GMS. Accepting this higher figure is highly plausible. Warehousemen, as collection agents for Wheat Commission assessments, would probably maintain accurate records of the bushels handled and monies to be forwarded to the Wheat Commission.

GMS and Special Survey: When only these two data sources were available, the reported throughputs would be expected to be quite close since facilities forwarded information individually. For the most part, this was true; however, Special Survey throughputs tended to be slightly higher than those contained in the GMS. This is explainable and understandable in as much as the yearly survey totals included figures for months that may not have been reported in the GMS.

Where this occurred, gaps were observed, almost invariably, in the months for which data existed in the GMS.

The general procedure described in Sub-section 1 was likewise used for elevators where only these two sources of data were available.

Wheat Commission and Special Survey: This data availability combination for elevators, while not prevalent, did occur. In such situations, the allocation of throughputs to particular destinations required special consideration, since the percentages for them were not available for 1979 from the GMS.

The procedures described in Sub-section 1 were followed in conjunction with the additional modifications described below, which specify how throughputs were allocated to particular destinations.

- If the GPW in question reported in other years to the GMS, (1976-1978), then the percentages to particular destinations for the most current year were used. If the modal split between rail and truck varied considerably from that reported in the survey, the survey modal totals were used as a basis for factoring "old" percentages to destinations to the "new" (survey based) control figures.
- If the GPW in question never reported to the GMS then, the nearest GPW (in terms of distance) which did report in 1979 was used as the basis for factoring percentages to destinations. The control totals for each mode indicated in the survey were used in the manner described above. This is a valid assumption, since it was observed in a detailed examination of grain movement data that shipment patterns were most similar for GPWs located near each other versus considering GPWs on the basis of their affiliation, ownership, or other considerations.

3. Only One Source of Data

For 17 GPWs, data was available from only one of the primary data sources for 1979.

In all, data was available from the Grain Movement System for 5 GPWs, from the Wheat Commission for 9 GPWs, and from the Special Survey for 3 GPWs.

For the GPWs where only Grain Movement System existed, the throughput figures and proportions to various destinations by means of transport were taken directly from GMS records. Where deemed necessary, these figures were adjusted to compensate for under or miss-reporting. The historical GMS records (1976-1978) for these elevators served as the principal basis for any changes.

For the GPWs where only Wheat Commission or Special Survey data were available, the procedure described in Sub-section 2 was followed.

4. Primary Data Not Available for 1979

For 7 GPWs, data was not available from any of the three primary sources for 1979. In these instances, 1979 throughputs and proportions were constructed on the basis of historical Grain Movement System data, aggregate Burlington Northern data and disaggregate Milwaukee Road data.

As a somewhat different situation existed in regard to each of these facilities, the procedures actually followed were developed on an ad hoc basis.

B. Unit Charges/Rates

The purpose of this section is to summarize the various charges and rates utilized in the GTCM to reflect revenues received for the storage/handling of grain at elevators and for transport first from GPU to GPW and/or GST, and then to the west coast markets. Documentation of the unit charges/rates contained herein not only establishes a record of the parameters used, but also provides a straightforward means for adjusting GTCM results should unit charges/rates change in the future.

Published or known rates/charges in effect during the late fall of 1980 have been utilized to the maximum extent possible. These rates cover basic transport, storage and handling services; they do not cover the costs of optional services associated with preparing grain or for rerouting or for in-transit privileges. Fuel surcharges have not been included primarily because of the difficulty of ensuring that such cost adjustments have been applied equally across all modes.

The following paragraphs describe the unit charges/rates used in the GTCM along with adjustments which have been made.

1. Rail

Published BN rail rates for export wheat and barley moving to Pacific North Coast destinations represents the principal information source used in computing railroad revenues and charges to growers. The rates are at the X375C level and reflect the single car reductions and multiple car rates introduced by the BN on December 1, 1980. Single car rates are used for rail movements through GPWs; 52 car unit train rates are used for rail movements through GSTs.

Although three different volume rates structures are presently in effect, the study considered only the 52 car volume rate, which is 15 cents per bushel under the single car rate.

The rates for export grain remains constant regardless of the port utilized. No adjustment was made for domestic wheat, since a majority of the destinations are Pacific North Coast cities.[1] Since the study focused exclusively on westbound wheat, the barley rates were not utilized. No allowance was made for additional income stemming from rerouting, demurrage, or other accessorial charges.

Listed below are sample rates used in the GTCM.[2]

TABLE 2

SAMPLE RATES ($/BU)

GST Site	Location	Export Wheat Single Car 7/12/80 *	12/1/80**	52 Car***	Barley Single Car
01	Pompey's Pillar	1.092	0.990	0.840	0.874
09	Benz	1.332	1.170	1.020	1.066
20	Mission	0.906	0.870	0.720	0.725
24	Moccasin	1.002	0.900	0.750	0.802
26	Kershaw	0.945	0.846	0.696	0.756
28	Havre	1.002	0.906	0.756	0.802
32	Saco	1.200	1.026	0.876	0.960
37	Macon	1.311	1.104	0.954	1.049
40	Homestead	1.356	1.158	1.008	1.085
52	Conrad	0.945	0.852	0.702	0.756

* Used in computing truck rates (see next section)
** Applicable to base case and residual movements through GPWs.
*** Applicable to movements through GSTs for Alternatives 2, 2A, 3, and 3

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[1] Had the July 12, 1980 rates been utilized, then it would have been necessary to adjust for the approximate five percent difference between export and domestic rates.

[2] For a more complete listing, see the statement on "Rail Freight Rates on Wheat and Barley from Montana Origins to Pacific North Coast Destinations" prepared by Radermacher & Associates, October 27, 1980.

2. Grain Trucks (Line Haul)

Unlike rail rates, truck rates are not published, although they are generally set a few cents a bushel less than rail rates. Truck rates are further complicated by several factors: (1) the willingness of truckers to accept rather low renumeration if the movement is a backhaul which otherwise the truck would be empty, (2) the ability of the major grain companies to somewhat arbitrarily establish the rates they are willing to pay from a given locality to a river terminal or the west coast, and (3) the premiums sometimes paid in order to take advantage of a market opportunity or simply meet a contractual commitment. Much of the fronthaul trucking is provided by independent owner/operators; backhaul movements could be provided by anyone heading west who has an empty vehicle.

Short of going out into the field and auditing or sampling GPW records, there is no easy way of firmly establishing what GPWs are paying for truck transportation. Even if this were done, great care would have to be exercised to make sure the rates were current. It should be recognized, however, that grain shipments do not occur on a uniform basis throughout the year and that any factoring done to normalize rates to a specific point in time (i.e., late fall, 1980) is at best quite speculative unless the particular movement is made frequently. Then there is the problem of identifying and properly adjusting backhauls and movements for which premiums are paid. Much would depend upon the memory of the GPW operator.

The best that can be done is to approximate grain truck revenues (charges to the grower) by using single car rail rates in existence prior to December 1, 1980 and then subtract (1) the cost of barge transport and river elevator thruput charges (0.196 $/bu) and (2) an additional six cents per bushel which is basically the "inducement" factor to use trucks. Furthermore, truck rates to interior Oregon and Washington points were increased by $0.027 per bushel to reflect the slightly higher rail rates for domestic movements.

3. Grain Trucks (GST-Supplied Collector Service)

The one area where rather firmly established truck rates do exist is for collector type grain movements to Billings and Great Falls. Rates have been established on a per mileage basis, as follows:

One-Way Mileage	Rate $/bu.	One-Way Mileage	Rate $/bu.
50	0.150	250	0.414
100	0.192	300	0.510
150	0.252	350	0.570
200	0.330		

These rates were converted to the following two equations which were then used in computing intermediate rates:

$$C = 0.9171 + (0.0009329 * D) + (0.0000013 * D^2) \quad \text{where } D \leq 50$$

$$C = 0.15171 + (0.0004338 * D) + (0.00000 * D^2) - (0.0000000132 * D3) \quad \text{where } D > 50$$

where: C = cost per bushel
D = distance (one-way)

4. Farm Trucks

Hauling grain in farm trucks is a cost to the grower. While this is typically thought of as one of the costs involved in producing grain, it can be treated as a transport charge, even though the service is performed by the grower.

In this study, farm truck costs are also considered to be charges to the growers and were computed using the following equation:

$$C = [(D * 2) * 0.748] / 425$$

D = distance (one-way)

where: C = cost per bushel

See Appendix Section C, Sub-section 1 for details on the derivation of this equation.

5. Barges and River Terminals

An average charge of $0.1437 per bushel was used for barge transport from Lewiston, ID. Additionally, a charge of $.0523 per bushel was used for handling and storage at river terminal facilities.

Barge rates at Almota and Central Ferry are slightly less ($0.1422 per bushel), although this is offset by slightly higher trucking charges.

6. GPWs

GPW rates are computed using the following equation:

$$R = \left[\frac{365}{\frac{T}{0.6S}} - 15 \right] * 0.001 + 0.105$$

where:
R = Rate ($/bu.)
S = GPW storage capacity (bu.)
T = Annual throughput (wheat and barley) (bu.)

This equation utilizes (1) the maximum charges permitted by the Montana Department of Agriculture for storing and handling grain (0.1 cents per bushel per day and 10.5 cents per bushel, respectively), (2) a free storage period of 15 days, and (3) a working storage of 60 percent of rated capacity.1/

1/ Actual handling charges may be somewhat less if there is strong competition among elevator operators.

It assumes that the available storage capacity is continually being utilized. It does not include revenue derived from other ancillary services such as cleaning.

7. GSTs

GST rates were computed using the following equation:

$$R = \left[\frac{\frac{365}{T}}{0.8S_1 \text{ or } S_2} \right] * 0.001 + 0.105$$

where R = Rate (\$/bu)
S_1 = Storage capacity of the GST (500,000 bu)
S_2 = Storage capacity of the GST(1,000,000 bu)
T = Annual throughput (wheat only) (bu.)

This equation again utilizes the maximum charges permitted by the Montana Department of Agriculture for storing and handling grain. A working storage of 80 percent of rated capacity has been utilized.

C. Unit Costs

The purpose of this section is to summarize the unit costs developed and utilized in the GTCM. These costs, which are macro scale judgements or estimates, were then applied on a per bushel or per mile basis to obtain transport and elevator costs. Documentation of unit costs contained herein not only establishes a record of the parameters used, but also provides a straightforward means for adjusting GTCM results should the unit cost picture change in the future.

Any mathematical model is only as good as the quality of the inputs; hence the need for very careful reasoning and cross-checking in developing unit costs to minimize the possibilities for unintended distortion of the resulting answers. This is not easy to do for the following reasons:

- If sufficient time and fiscal resources are available, then it is possible to dig out rather detailed information on the organizations, infrastructure/equipment, and general economics involved in providing transport services. Such research is typically carried out on a sample basis using in-depth interviews with traffic managers and accounting personnel to obtain information from which to derive unit costs. The resources available in this study did not permit this course of action however.

- If the transport or elevation service is provided by many firms and/or individuals, there obviously are multiple unit costs. These costs, known to the businessman, are not the type of information which is readily furnished to the public sector simply because accidental disclosure may adversely affect competitive relationships.

- In such circumstances, additional assumptions regarding organization (e.g., company or independent), infrastructure/equipment (e.g., age, cost, depreciation, labor inputs, operating efficiency) and utilization have to be made before attempting to estimate unit costs.

- In developing unit costs with a limited budget, one is forced to rely primarily on telephone conversations, secondary information, and professional judgement to identify and refine cost components, which are then combined to produce a unit cost. Once a reasonable value has been established, then it is carefully cross-checked with related information as well as reviewed and discussed with persons knowledgeable of such costs to obtain an outside opinion as to its overall reasonableness. Only then is the unit cost applied to GTCM computations.

- Even were the transport service provided by a single firm (e.g., BN), it still becomes necessary to independently estimate unit costs simply because of the reticence of private companies to share such information with government.

Thus, there is no single "right" answer -- only carefully reasoned estimates which seek to capture in one number the collective experience of many individuals and firms. These unit costs include both variable and fixed components (i.e., are fully-allocated). They reflect steady state experience although in several instances they are constrained by available revenues.1/

The following paragraphs describe the unit costs used in the GTCM along with the principal parameters. Values shown are as of mid to late fall, 1980.

1/ Much depends upon the bargaining power of the companies purchasing transport services and the intensity of intramodal competition. Unit costs can exceed unit revenues. Obviously this situation cannot be continued indefinitely, although in the short run various adjustments are made to bring costs in line with available revenues. Postponing equipment acquisition, deferring maintenance, cutting back on corporate expenses, reducing employment are just a few of the ways of controlling costs in the short run so as to remain in business. In other instances, profit margins are so slim that unit costs essentially equal unit revenues. In such instances, it makes little sense to try and construct unit costs.

1. Farm Trucks.

Single unit two and three axle trucks owned and operated by growers are generally used to transport grain to GPWs. Vehicle payloads range from 350 to 500 bushels. An average unit cost of $0.748 per mile was derived based on the following parameters:

- Average operating speed - 45 mph.
- Estimated fuel consumption - 8 mpg.
- Average vehicle cost (new) - $30,000.
- Average driver salary - $5.00/hr.
- Insurance cost - $900/yr.
- Maintenance cost - $700/yr.
- Tire cost - $130/yr.
- Fuel Price - $1.176/gal.
- Annual mileage - 10,000.
- Useful service life - 10 yrs.

This cost was subsequently applied on a round trip basis to farm truck movements from GPUs to GPWs (and later on to GSTs if the one way mileage was 35 miles or less), using 425 bushels for average payload. (See Appendix Section B, Sub-section 4 for equation).

2. Grain Trucks (Line Haul)

Two types of tractor/semi-trailer rigs are typically used to transport grain from GPWs to river terminals or west coast markets. The first are specially constructed semi-trailers having double hopper bottoms and capable of carrying 1100 to 1200 bushels. The second consists of varied box-type semi-trailers temporarily outfitted to haul 800 to 1000 bushels as a backhaul movement. Average unit costs of $1.427, $1.27, and $1.15 per loaded mile were derived for loaded mileage/total mileage ratios of 70, 80, and 90 percent, respectively, based on the following parameters:[1/]

[1/] References: (1) "Owner-Operator Truck Cost Guide", USDA Office of Transportation, April, 1980 and (2) Jansen, D.R., "An Analysis of the Costs of Truckload Freight Operations", Economics and Finance Department, Association of American Railroads, August 1979.

- Equipment ownership - driver owned/operated
- Depreciation method - straight line.
- Miles operated per year - 99,700.
- Fuel price - $1.12/gal.
- Estimated fuel consumption - empty - 6,273 mpg.
  grain - 3.162 mpg.
  plywood- 3.802 mpg. (backhaul)
- Operating Expense (Cents/mi.)

- Driver	22.1	- licences/permits	1.2
- Driver Expense	3.5	- federal tax	0.2
- Capital	22.0	- state/local tax	0.5
- Maintenance	10.5	- insurance	5.0
- Tire	1.5	- overhead	3.5

This cost was subsequently applied on a one-way trip basis for grain movements from GPWs to river terminals or west coast markets. Average payload was 1017 bushels.

3. Grain Trucks (GST-Supplied Collector Service)

Tractor/semi-trailer rigs specially designed for hauling grain would be used on a contractural basis to transport grain from GPWs or GPUs to GSTs. Payload was assumed to be 1017 bushels. Assuming an empty backhaul, the average cost would amount to $1.933 per loaded mile (using the parameters in Sub-section 2 above adjusted to reflect this type of service), which is well above established rates for such service. Consequently, costs were set equal to rates for this type of service.

4. Rail Costs (Single Car Service)

The method used to cost out single car rail service utilizes standard ICC costing procedure based on computing the following three components.[1]

• Terminal Cost	Load unloading and terminal switching cost.
• Way Train Costs	Costs of hauling from a GPW to a local yard on the origin end and from a local yard on the destination end to the flour mill, malt house, or terminal elevator.
• Through Train Costs	Line haul and inter and intra train switching costs.

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[1] References: (1) Statement No. 1C1-77, "Railroad Carload Cost Scales-1977, November, 1979 Page 126" and Notice 3006-02 "Rail Update Ratios," both published by the Interstate Commerce Commission, Bureau of Accounts.

Variable inputs included:

- Weight
- Distance in shortline miles

Constant inputs included:

- Average car weight - 64 tons/box car 96 tons/hopper
- Average way train mileage - 102 miles
- Circuity factor - 1.17 for box cars 1.18 for hopper cars (takes indirect routings into consideration.)
- Temporal growth factor - 1.396 (to grow 1977 costs to 1980)
- Car mix factor 1.116 (to account for a mixture of box and hopper cars instead of straight hopper cars.)
- Various cost factors - (See Table 3)

The method is first used in computing the cost of moving a single carload. Then the total traffic (in tons) is divided by the weight per car to obtain the number of cars, which is then multiplied by the single carload cost to yield total movement cost. A small computer program was written to calculate both variable and fully allocated costs for single car movements from selected stations in Montana and North Dakota to Portland on the BN.[1/] The results of these calculations were then reviewed with persons knowledgeable about rail costs and rates to establish their reasonableness (See Figure 1). The program was then employed to compute single car rail costs from all stations in Montana.

[1/] ICC defines variable costs as "freight operating expenses, rents, and taxes (excluding Federal Income Taxes) plus an allowance for the cost of capital before Federal Income Taxes on 50 percent of the road property and 100 percent of the equipment used in freight service". Fully allocated costs are defined as "in addition to the variable costs ...... include the remaining portion of the freight operating expenses, rents, and taxes (excluding Federal Income Tax)." Fully allocated costs were used in this study.

TABLE 3

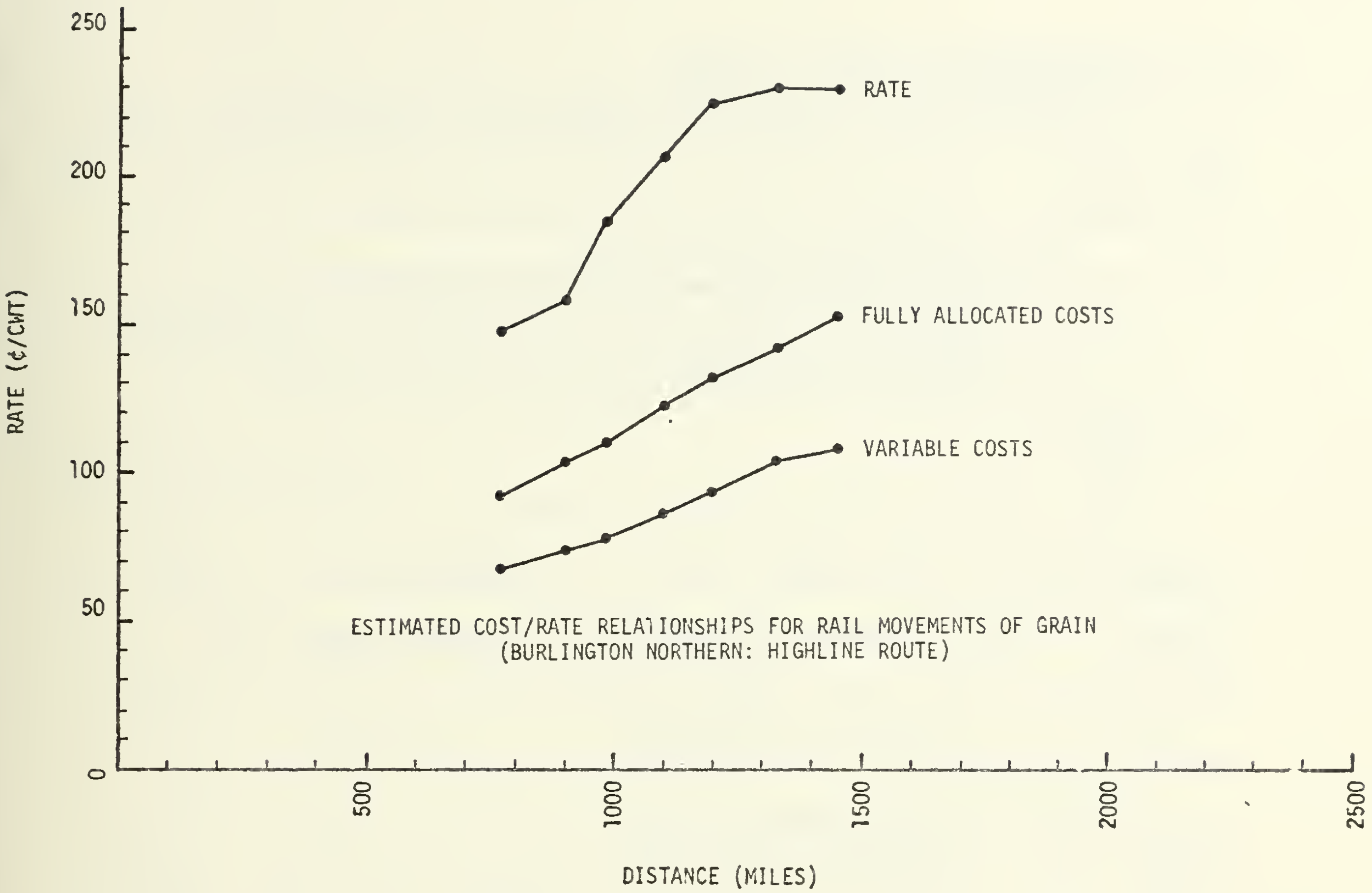
COMPONENT COST FACTORS 1/

Item		Unequipped Box	Covered Hopper	
Variable Cost				
Terminal:	per carload	17735.406	17735.406	
	per cwt	0.124	0.124	
	total per cwt	13.980	9.361	(1)
Way Train:	per car-mile	69.94698	58.41394	
	per cwt-mile	0.02973	0.02973	
	total per cwt-mile	0.08438	0.06015	(2)
Through Train:				
	per car-mile	53.15459	45.79025	
	per cwt-mile	0.01938	0.01938	
	total per cwt-mile	0.06091	0.04323	(3)
Mileage:	Total	variable	variable	
	Way Train	102	102	(4)
	Through Train	D-102	D-102	(5)
Constant Expense				
Terminal Cost per cwt		3.749	3.749	(6)
(Line-Haul Cost per cwt)		0.01785	0.01785	(7)
Fully Allocated Cost				
Way Train per cwt-mile		[(2) + (7)] X 1.17		(8)
Through Train per cwt-mile		[(3) + (7)] X 1.17		
Total Terminal Cost per cwt		(1) + (6)		
Total Way Train Cost per cwt		(8) X (4)		
Total Through Train Cost per cwt		(9) X (5)		

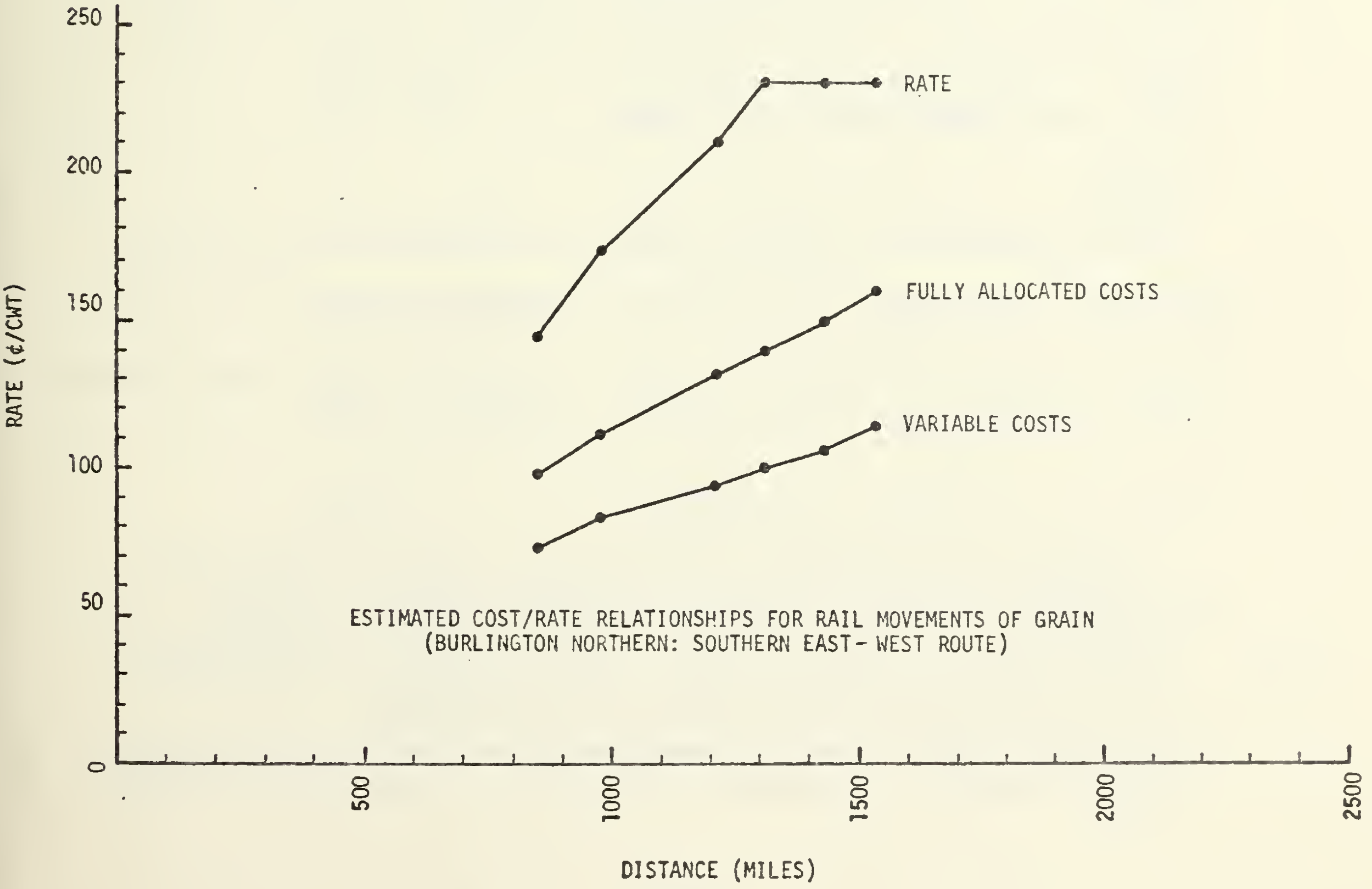
Note: to eliminate interchange costs, subtract 3.53678 (box cars) and 3.60896 (hopper cars) from way and through train per car-mile variable costs and 0.00052 from line haul cost per cwt.

1/ 1977 data.

FIGURE 1



ESTIMATED COST/RATE RELATIONSHIPS FOR RAIL MOVEMENTS OF GRAIN
(BURLINGTON NORTHERN: HIGHLINE ROUTE)



ESTIMATED COST/RATE RELATIONSHIPS FOR RAIL MOVEMENTS OF GRAIN
(BURLINGTON NORTHERN: SOUTHERN EAST- WEST ROUTE)

5. Rail Costs (Unit Train Service)

The ICC single car algorithm was modified for estimating unit train costs by

- eliminating way train costs
- eliminating inter or intra train switching costs
- reducing clerical costs by 25 percent per carload and 75 percent per shipment
- reducing terminal switching costs by 75 percent

6. Barge

Several firms (Knappton, Crowley, Tidewater, and Shaver) provide for-hire barge services on the Snake and Columbia Rivers. The barge industry is largely unregulated and exempted from ICC regulations. Hence there is a near total dearth of public sector information on the cost of barge transport. With the intense competition taking place, companies have not been willing to provide unit cost information for use in this study. Consequently the decision was made to set costs equal to rates for this type of service, recognizing that undoubtedly a small profit is being made by the barge companies.

7. GPWs

Even though GPWs or country elevators are regulated by the Montana Department of Agriculture, the agency does not have reliable cost information on elevator operations.[1/] Hence, it was necessary to modify/update an earlier USDA study to provide approximate unit costs.[2/]

[1/] Although cost information is presented by industry witnesses at hearings concerning changes in storage and handling charges, such information is usually a subset designed to support the basic thrust of the testimony -- provide justification for the proposed rate charges. It simply was not considered to be a comprehensive or reliable enough source to utilize in this study.

[2/] Reference USDA, "Cost of Storing and Handling Grain and Controlling Dust in Commercial Elevators, 1971-1972 ..... Projections for 1973-1974".

The data contained in the USDA study has been adapted to Montana by applying a regional adjustment and inflation factors. The USDA study found that country elevator costs in the far west were higher than the national average primarily in the area of receiving and shipping costs. Consequently, a factor of 1.10 was applied. A series of inflation factors were developed and applied for the various cost components as outlined below:

Cost Component	Index	Factor
Depreciation	Commercial & Factory Building	1.79
Insurance	Commercial Multiperil Insurance	2.39
Taxes	Federal, State, and Local Tax Collections	1.91
Licences & Bonds	Consumer Price	1.66
Direct Labor Adm. & OVH	Average Annual Wages for Wholesale & Retail Trade	1.66
Elec. & Heat	Fuel & Other Utilities	1.87
Truck Expenses	Motor Vehicles & Equipment	1.61
Building Repairs Equip. Repairs.	Maintenance & Repairs	1.68
Grain Insurance Taxes on Grain.	Producer Price Index-Grains	1.01
Fumigation Other.	Producer Price Index-All Commodities	1.78

Table 3 shows estimated 1980 country elevator component costs per bushel of capacity for both truck and rail oriented facilities. These cost components were utilized to derive the following cost equation:

TABLE 4

1980 COUNTRY ELEVATOR COMPONENT COST PER BUSHEL OF CAPACITY

Cost Component	Handling Costs Truck/Rail	Handling Costs Truck/Truck	Storage Costs
Fixed Cost			
Depreciation	1.05	0.92	4.18
Insurance	0.16	0.14	1.71
Taxes	0.18	0.18	2.34
Licences/Bonds	-	-	0.26
Interest on Investments	0.77	0.68	6.64
Sub-total	2.16	1.92	15.13
Variable Costs			
Direct Labor	3.05	2.57	2.42
Adm OVH	1.91	1.95	1.82
Elec & Heat	0.44	0.43	0.14
Truck Expenses	0.43	0.59	-
Bldg Repairs	0.02	0.02	0.97
Equip Repairs	0.57	0.52	0.15
Grain Insurance	-	-	0.51
Taxes on Grain	-	-	0.14
Fumigation	-	-	0.27
Other	1.10	1.10	0.35
Int. on Working Capital	0.23	0.22	0.20
Sub-total	7.75	7.40	6.97
Total Costs	9.91	9.32	22.10

$$C = \frac{.1717 * S}{T} + 0.00019 * \left[\frac{365}{\frac{T}{.6S}} - 15 \right] + 0.07575$$

where:
C = Cost ($/bu)
S = GPW storage capacity (bu.)
T = Annual throughput (wheat + barley) (bu.)

The first term calculates the fixed or capital unit cost component. The second term computes the variable unit cost for storage. The term in brackets represents the number of days a bushel is in storage less the 15 free days customarily provided. The last term computes the variable unit cost for handling. Working capacity was assumed to be 60 percent of storage capacity.

8. GSTs

An analogous equation was derived for GSTs, as follows:

$$C = \begin{matrix} 0.8863 * \frac{S_1}{T} \\ \text{or} \\ 0.5636 * \frac{S_2}{T} \end{matrix} + 0.00016 * \left[\frac{365}{\frac{T}{.8S_1 \text{ or } .8S_2}} \right]$$

where:
C = Cost ($/bu.)
S_1 = GST Storage Capacity (500,000 bu.)
S_2 = GST Storage Capacity (1,000,000 bu.)
T = Annual throughput (wheat only) (bu.)

In this case, working capacity was assumed to be 80 percent of storage capacity.

9. River Terminals

Costs were set equal to the average $0.0523 per bushel charge levied for handling and storage.

D. Determining Economic Feasibility

This section summarizes, in equation form, the calculations made to determine the economic feasibility of GSTs. Economic feasibility is primarily measured by the reduction in transport charges. Of lesser interest is the reduction in transport costs and the redistribution of volumes, costs, and revenues occurring from the implementation of GSTs.

1. Traffic

Traffic movements between points of commonality (GPUs, West Coast Markets) can be represented as:

Base Case Vb [GPU → GPW → Mkt]

Alts 2, 2A Vs [GPU → GPW → GST → MKT]
Vr [GPU → GPW → Mkt]

Alts 3, 3A Vs [GPU → GST → Mkt]
Vr [GPU → GPW → Mkt]

Where Vb = base case grain flow = 109.9 mil.bu = Vs + Vr
Vs = subterminal grain flow= 86.0 mil.bu (9 GSTs) or 88.7 mil.bu (10 GSTs)
Vr = residual grain flow = 23.9 mil.bu (9 GSTs) or 21.2 mil.bu (10 GSTs)

Each of the above flows is comprised of a number of mode/destination components; as outlined:

Base Case	GST Alternatives
Pacific North Coast (rail)	-
Pacific North Coast (truck)	Residual=0.15 X Pacific North Coast (truck)
Interior OR/WA (truck/barge)	Residual=0.15 X Interior OR/WA (truck/barge)
Interior OR/WA (rail)	Residual=0.50 X Interior OR/WA (rail)
Idaho (truck/barge)	Residual=0.15 X Idaho (truck/barge)
–	Pacific North Coast (GSTs/unit trains)

2. Residual Traffic

It was found that in virtually all cases, transport charges would be reduced were GSTs used in lieu of GPWs. Thus, were a "mode split" to be made on the basis of user economies, the projected outcome would have been a near total diversion from the present to the proposed mode. Such drastic shifts are quite rare. In the end, an approach based on reasoning out what the maximum market share might be for GSTs and unit trains was employed rather than an objective process based solely on savings in transport charges. Other constraints were similarly applied to develop the residual traffic volumes shown in the previous section.

	Traffic (000 bu.)	
	Potential Subterminal	Residual
Total Wheat	119,820.8	
Westbound Wheat	109,896.7	
Wheat within Practical Distance of GSTs	108,643.5	1,253.2
Market Share Limit on Wheat Thru GSTs	88,687.4	19,956.1
GSTs not Viable [1]	86,048.9	2,638.5
Final Market Shares	86,048.9	23,847.8
Percent	78.3	21.7

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[1] Excludes GST # 20

3. Main Components

All calculations undertaken to determine transport charges/revenues and costs are performed using one of the following generalized equations:

R_i = (Volume) X (Distance) X (Unit revenue/charge) (1)

R_i = (Volume) X (Unit revenue/charge) (2)

C_i = (Volume) X (Distance) X (Unit cost) (3)

C_i = (Volume) X (Unit cost) (4)

where: R_i = Total revenues/charges for sub-component i

C_i = Total costs for sub-component i

The distances to be utilized in equations (1) and (3) vary, as indicated below:

	Revenue/Charge or Cost		
Mode	V_b and V_r	V_s (Alt 2, 2A)	V_s (Alt 3, 3A)
Rail (Single Car Service)	GPW → MKT		
Rail (Unit Train)		GST → Mkt	GST → Mkt
Grain Truck (Line Haul)	GPW → Mkt/River Port		
Grain Truck (Collector)		GPW → GST	GPU → GST[1]
Farm Truck	GPU → GST	GPU → GST	GPU → GST[2]

---

[1] where the distance (one-way) is greater than 35 miles.

[2] where the distance (one-way) is equal or less than 35 miles.

The GTCM can be broken down into the six major components below for each of the types of grain movements:

Grain Movement	Total Revenues/charges	Total Costs
Base Case (V_b)	R_b	C_b
Subterminal (V_s)	R_s	C_s
Residual (V_r)	R_r	C_r

4. Sub-Components

Each of the above listed main components represents the tabulation of relevant sub-components for a type of grain movement. Table 5 details (1) the general form of the sub-component tabulation; (2) a reference to the section in the appendix where a given unit revenue/charge/cost is discussed, and (3) the type of data input or calculation of sub-component factors for each type of grain movement.

5. Final Equations for Revenues and Costs

Each of the main revenue/charge/cost components for a given type of grain movement are tabulated by the equations below:

$$\text{Base Case Revenues} = R_b = V_b[R_1 + R_3 + R_5 + R_6 + R_7] \quad (5)$$

$$\text{Sub-terminal Revenues} = R_s = V_s[R_2 + R_4 + R_6 + R_8] \quad (6)$$

$$\text{Residual Revenues} = R_r = V_r[R_1 + R_3 + R_5 + R_6 + R_7] \quad (7)$$

$$\text{Base Case Costs} = C_b = V_b[C_1 + C_3 + C_5 + C_6 + C_7] \quad (8)$$

$$\text{Sub-terminal Costs} = C_s = V_s[C_2 + C_4 + C_6 + C_8] \quad (9)$$

$$\text{Residual Costs} = C_r = V_r[C_1 + C_3 + C_5 + C_6 + C_7] \quad (10)$$

where: R_1 = Rail (Single Car Service) revenues/charges

R_2 = Rail (Unit Train) revenues/charges

R_3 = Grain Truck (Line Haul) revenues/charges

R_4 = Grain Truck (Collector) revenues/charges

R_5 = Barge/River Terminal revenues/charges

TABLE 5

REVENUE/CHARGE/COST SUB-COMPONENTS

	Revenue/Charge for Sub-Component						Cost for Sub-Component					
Sub-Component	Variable Name	Appendix Reference Section	Data 1/ Input	V_b 2/	V_s 2/	V_r 2/	Variable Name	Appendix Reference Section	Data 1/ Input	V_b 2/	V_s 2/	V_r 2/
Rail (Single Car Service)	R_1	B1	1	(2)		(2)	C_1	C4	2	(3)		(3)
Rail (Unit Train)	R_2	B1	1		(2)		C_2	C5	2		(3)	
Truck (Line Haul)	R_3	B2	2	(1)		(1)	C_3	C2	2	(3)		(3)
Truck (Collector)	R_4	B3	2		(2)		C_4	C3	3		(4)	
Barge/River Terminal	R_5	B5	1	(2)		(2)	C_5	C6	3	(4)		(4)
Farm Truck	R_6	B4	4	(2)		(2)	C_6	C1	2	(4)		(4)
Public Warehouse	R_7	B6	2	(2)		(2)	C_7	C7	2	(4)		(4)
Subterminals	R_8	B7	2		(2)		C_8	C8	2		(4)	

where: V_b = Base Case Traffic

V_s = Subterminal Traffic

V_r = Residual Traffic

1/ Code referring to type of data input for unit revenue/ charge cost

1 = Unit revenue/charge/cost directly available from primary source
2 = Unit revenue/charge/cost is calculated from other unit input data
3 = Unit cost is set equal to the revenue/charge (C=R)
4 = Unit revenue/charge is set equal to the unit cost (R=C)

2/ The number in parentheses indicates the generalized equation in Section D, Subsection 3 used in calculating either total revenues/ charges or total costs each sub-component.

R_6 = Farm Truck revenues/charges

R_7 = Public Warehouse revenues/charges

R_8 = Subterminal revenues/charges

C_1 = Rail (Single Car Service) costs

C_2 = Rail (Unit Train) costs

C_3 = Grain Truck (Line Haul) costs

C_4 = Grain Truck (Collector) costs

C_5 = Barge/River Terminal costs

C_6 = Farm Truck costs

C_7 = Public Warehouse costs

C_8 = Subterminal costs

6. Economic Feasibility

To the user (grower), overall economic feasibility is determined by the reduction in transport charges, which is given by:

$$\text{Reduction in charges} = (R_s + R_r) - R_b \tag{11}$$

where: R_s = Total charges for subterminal traffic

R_r = Total charges for residual traffic

R_b = Total charges for base case traffic

To the suppliers of rail transport services, overall improvements in the efficiency of their operations are measured by:

$$\text{Changes in income} = R^R_{(s,r)-b} = (V_s * R_2 + V_r * R_1) - V_b * R_1 \tag{12}$$

$$\text{Changes in expenses} = C^R_{(s,r)-b} = (V_s * C_2 + V_r * C_1) - V_b * C_1 \tag{13}$$

$$\text{Change in profitability} = \frac{(V_s * R_2 + V_r * R_1)}{(V_s * C_2 + V_r * C_1)} - 1 \tag{14}$$

versus

$$\frac{V_b \ * \ R_1}{V_b \ * \ C_1} \ -1 \qquad (15)$$

where: $R^R_{(s,r)\ -b}$ = Net income alternative (s,r) versus base case (b) traffic for the railroad

$C^R_{(s,r)\ -b}$ = Net expenses alternative (s,r) versus base case (b) traffic for the railroad

R_1 = Rail charges (single car services)
R_2 = Rail charges (Unit train)
C_1 = Rail costs (single car service)
C_2 = Rail costs (unit train)
V_b = Base case traffic
V_s = Subterminal traffic
V_r = Residual

Similar relationships may be developed from the equations presented in this section of the appendix and used for assessing the economic feasibility for each of the principal actors in the grain movement process. These relationships, while not presented here, were used in arriving at the results reported in the main report.

7. Tabulations

Tabulations presenting total Charges/Revenues and Costs have been prepared at five different levels of aggregation: GPU, GPW, County-level, GST tributary area, and State-level.[1/] Tabulations presenting charges/revenues and costs for rail, motor carriers, barges, farm trucks, GPWs and GSTs have been prepared on a GST-tributary area and for the state as a whole. Each tabulation consists of separate tables for the base case, residual traffic, and the four alternatives (2, 2A, 3, and 3A).

[1/] Confidentiality requirements to not permit the publication of GPU and GPW level summaries, or the discemination of this information to the general public.

E. Highway and Rail Network Development

The coding of transportation networks into machine-readable form to permit computerized traffic assignments has long been a methodology employed by planners to determine traffic and vehicle miles of travel changes between a hypothesized future and the present situation. Such networks have been employed in this study as an accounting device.

Both the highway and rail network utilize conventional coding practices: trackage or highway segments being represented by links and connections between segments and to GPWs and GSTs being represented by nodes. The following describes in greater detail the characteristics of each:

1. Rail Network

The rail network only includes segments utilized for the transport of grain; thus it does not incorporate all branchlines in the state. It does include generalized network extensions westward to Seattle and Portland. A total of 710 rail links were identified, for which the following information was collected for each:

- railroad subdivision
- length (miles)
- load limit
- authorized maximum operating speed
- estimated scheduled running time
- trains per week
- 1979 traffic density (millions of gross tons per mile per year)

In assigning traffic to this network, use was made of routings developed through professional judgment rather than through mechanically determining the shortest distance route. The sparsity of the rail network coupled with the fact that train movements do not always follow the shortest route dictated this approach.

Thus, the rail network volumes shown on figures included in the report text represent RCAI-estimated one-way movements of loaded rail cars from GPWs to West Coast markets or market gateways. Rail car figures are based on an average loading of 79 tons per car for GPW originating traffic (comprised of 57 percent covered hoppers at 96 tons per car and 43 percent grain boxes at 64 tons per car) and 100 tons per covered hopper for GST-originated traffic.

2. Highway Network

The coded highway network includes state highway segments utilized for the transport of grain from GPWs to west coast markets, plus connecting segments which would potentially be utilized depending upon the location of GSTs. Separate accounting was made of the distance and volumes moving from GPUs to GPWs.[1]

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[1] From a network perspective, grain traffic is presumed to originate at GPWs, rather than at GPUs. However, this is not a serious limitation inasmuch as the large majority of farm truck VMT is on county roads rather than state highways. The alternative to this would have been a more extensive network incorporating county roads from GPU centroids to the state highway segments. The advantage of such a network is the ability to capture farm truck movements between GPUs and GPWs, as well as any mileage changes resulting from bypassing GPWs on movements made directly from GPUs to GSTs under Alternatives 3 and 3A. The disadvantage is the rather sizable increase in the number of links required in order to account for all movements. It was recognized that the portion of GPU to GPW movements made over the state highway system would not be recorded as being on that network (the mileage was lumped in with the mileage from GPU to GPW). It was felt that the use of the GPW location as a proxy for the entry point onto the state highway system would not introduce any serious distortions as the added distance on one GPU-GPW-GST movement would be offset by the shorter distance on the next such movement. Based on the above, the decision was made to use the simpler network, recognizing that the farm truck volumes in the immediate vicinity of GPWs would be less than that actually occurring.

Also included are generalized network extensions westward to Lewiston, ID via Route 12 (Lolo Pass) and to Portland, OR and Seattle, WA via Interstate 90. A total of 1080 highway links were identified, for which information was collected for each segment:

- route number
- length (miles)
- functional classification
- jurisdiction
- free flow speed
- existing daily truck volume

In assigning traffic to the network, use was made of routings developed through professional judgment. Again, the routes used for grain movements are fairly obvious, although in several areas, traffic was "split" between alternative routings. Grain moving west from the Golden Triangle can utilize either Route 200 from Great Falls to Missoula or Interstate 15 to Helena, Route 12 to Garrison, and Interstate 90 to Missoula. Considerable time was spent seeking information on the utilization of each route by grain trucks; in the end, a lack of hard information dictated the use of a "judgmental" split for such traffic between the two routings. Similarly, grain trucks headed to Lewiston, ID have the choice of using Route 12 through Lolo Pass, Interstate 90 to Coeur d'Alene, ID and Route 95, or Interstate 90 to Spokane, WA and Route 195. In all cases, the tradeoff is one of a shorter, slower, less desirable route (in terms of pavement condition, cross-section, and/or horizontal and vertical alignment) versus a longer but faster route involving the use of the Interstate system.

Thus, the highway traffic volumes shown on figures included in the report text represent RCAI-estimated annual one-way movements of loaded (1) grain trucks from GPWs to markets or river terminals (both for the base case and the residual traffic included in the four alternatives) or GSTs (all movements for Alternatives 2 and 2A and movements greater than 35 miles for Alternatives 3 and 3A) and (2) farm trucks from GPWs to GSTs for movements of 35 miles or under in the case of Alternatives 3 and 3A. Vehicle counts are based on loadings of 1017 bushels for grain trucks and 425 bushels for farm trucks.

F. Highway Impact Computations

Recognizing that any significant increase in highway impacts is most likely to occur in the vicinity of GSTs, and that reduction in impacts were most likely along the principal grain-hauling routes to the west, (e.g., Route 200), an approach based on identifying the significance of changes in equivalent annual load applications (EALA) was adopted for approximating highway impacts.

The following computational process was utilized:

1. First, farm and grain truck volumes were summarized on a link basis for each of the alternatives as well as the base case. From this, the change in farm and grain truck volumes caused by the implementation of GSTs was computed.
2. Next, farm and grain truck volume changes were translated into EALA equivalents, which neutralizes the difference in vehicle types.
3. Using MDH (a) estimates of annual daily traffic by link, (b) classification counts giving the percentage of vehicles which are trucks, and (c) EALA factors computed from truck weight study data, base year traffic was then translated into EALA equivalents on a link basis.
4. The EALA equivalents computed in Steps 2 and 3 were compared by dividing the prospective change (Step 2) by the base traffic (Step 3) to determine the relative impact of GSTs.

Present EALA for each road segment in the highway network was computed using the following equation:

$$\mathrm{EALA}_p = \mathrm{ADHT} \times \mathrm{CLF} \times \mathrm{E} \times 365 \qquad (16)$$

where: ADHT = average daily heavy truck volume (supplied by MDH)

CLF = Critical Lane Factor 0.4 for Interstate and 0.5 for all other roads

E = 18-kip single-axle equivalent constant =

1.2 for Interstate, 1.0 for Primary, and 0.8 for Secondary highways. Derived from the W-4 tables for the 1978 truck weight study (for FHWA).

EALA was computed for the two scenarios using the following basic equation:

$$EALA_s = CLF \times [(FT_s \times E_{FT})-(GT_s - GT_B) \times E_{GT}] \times [(\text{farm trucks - farm trucks}) \qquad (17)$$

where: $EALA_s$ = EALA for scenario for a road segment

FT_s = Number of farm trucks on a road segment

GT_s = Number of grain trucks on a road segment

E_{FT} = 18-kip single axle equivalent constant for farm trucks

E_{GT} = 18-kip single axle equivalent constant for grain trucks

These computations were done twice; once assuming the trucks were legally loaded and once assuming that the trucks were overloaded.[1]

		18-kip single-axle equivalent constants[2]	
		Primary	Secondary
farm truck[3] -	empty	0.0528	0.0387
	loaded (legal)	0.9072	0.7946
	overloaded	1.3770	1.3084
grain truck[4]	empty	0.1416	0.1066
	loaded (legal)	2.4850	2.3595
	overloaded	4.1312	3.6875

---

[1] Information received from elevator operators implies that farm trucks are severely overloaded. This is understandable in that farm trucks largely utilize state secondary and county roads with little enforcement of load limits being practices, nor are grain growers aware of the axle loadings involved. Grain trucks also appear to be overloaded. While Montana does have permanent weigh stations, they can be bypassed by waiting until the stations are closed or by using alternative routings. MDH records imply load limit compliance, but such data are probably not representative of grain truck movements. Thus, given the uncertainty associated with truck axle configurations and average loaded weights, computations were done assuming both legally and overloaded conditions and the answers arrayed as a "range".

[2] Source: George Posten, MDH. Subsequently modified.

[3] Assumes 50 percent of farm trucks are 2-axle, dual rear tired vehicles carrying 8 tons (267 bu) legally loaded or 10 1/2 tons (350 bu) overloaded and 50 percent are 3-axle, dual rear tired vehicles carrying 13 tons (433 bu) legally loaded or 15 tons (500 bu) overloaded.

[4] Assumes 18 wheel, 5-axle rigs are utilized. MDA calculations indicate that such vehicles can haul 25 tons (830 bu) legally loaded and 30.5 tons (1017 bu) overloaded.

Ideally, EALA should be computed directionally. This was not possible given the nature of the base data. Consequently, the constants finally utilized were derived as follows from those given above:

farm truck = loaded (legal or overloaded) + empty (18)

grain truck in line haul service = 1.6 X loaded (legal) + 0.4 X empty, or 1.0 X overloaded + 0.6 X legally loaded + 0.4 X empty 1/ (19)

grain truck in collector service = loaded (legal or overloaded) + empty (20)

By making use of the general equations (16) through (20), all EALA calculations are reduced to the following set simple equations:

- Present Heavy Truck Traffic

Interstate: $EALA_p = 175.2 \times ADHT$ (21)

Primary: $EALA_p = 182.5 \times ADHT$ (22)

Secondary: $EALA_p = 91.25 \times ADHT$ (23)

where: $EALA_p$ = Present overall EALA on a road segment

ADHT = Average daily heavy truck volume

- Grain Trucks and Farm Trucks

Interstate and Primary Roads:

$$EALA_B^L = 2.0163 \times GT_B^L \quad (24)$$

$$EALA_B^0 = 2.8394 \times GT_B^0 \quad (25)$$

$$EALA_S^L = (.48 \times FT_S^L) + (2.0163 \times GT_R^L) + (1.3133 \times GT_S^L) \quad (26)$$

1/ Assumes an 80 percent load factor, with the backhaul (to the grain movement) being legally loaded.

$$EALA^{0}_{S} = (.7149 + FT^{0}_{S}) + (2.8394 \times GT^{0}_{R}) + (2.1364 \times GT^{0}_{S}) \qquad (27)$$

Secondary Roads : $$EALA^{L}_{B} = 1.9089 \times GT^{L}_{B} \qquad (28)$$

$$EALA^{0}_{B} = 2.5729 \times GT^{0}_{B} \qquad (29)$$

$$EALA^{L}_{S} = (.4167 \times FT^{L}_{S}) + (1.9089 \times GT^{L}_{R}) + (1.2331 \times GT^{L}_{S}) \qquad (30)$$

$$EALA^{0}_{S} = (.6736 \times FT^{L}_{S}) + (2.5729 \times GT^{L}_{R}) + (1.8971 \times GT^{L}_{S}) \qquad (31)$$

where: $EALA^{L}_{B}$ = EALA for legally loaded trucks for base case traffic

$EALA^{0}_{B}$ = EALA for overloaded trucks for base case traffic

$EALA^{L}_{S}$ = EALA for legally loaded trucks for scenario traffic

$EALA^{0}_{S}$ = EALA for overloaded trucks for scenario traffic

GT^{L}_{B} = Number of legally loaded grain trucks (line haul service) for base case traffic

GT^{0}_{B} = Number of overloaded grain trucks (line haul service) for base case traffic

FT^{L}_{S} = Number of legally loaded farm trucks for scenario traffic

FT^{0}_{S} = Number of overloaded farm trucks for scenario traffic

GT^{L}_{R} = Number of legally loaded grain trucks (line haul scenario) residual traffic

GT^{0}_{R} = Number of overloaded grain trucks (line haul service) for residual traffic

GT_S^L = Number of legally loaded grain trucks (collector service) for scenario traffic

GT_S^0 = Number of overloaded grain trucks (collector service) for scenario traffic

Using the results of computations from equations (21) through (31) changes in EALA may be computed as follows:

$$EALA_{P-F}^L = EALA_p + (EALA_S^L - EALA_B^L) \qquad (32)$$

$$EALA_{P-F}^0 = EALA_p + (EALA_S^0 - EALA_B^0) \qquad (33)$$

$$\%\ EALA_{P-F}^L = \frac{EALA_F^L - EALA_p}{EALA_p} \times 100 \qquad (34)$$

$$\%\ EALA_{B-F}^L = \frac{EALA_F^0 - EALA_p}{EALA_p} \times 100 \qquad (35)$$

$$\%\ EALA_{B-F}^L = \frac{EALA_S^L - EALA_B^L}{EALA_B^L} \times 100 \qquad (36)$$

$$\%\ EALA_{B-F}^0 = \frac{EALA_S^0 - EALA_B^0}{EALA_B^0} \times 100 \qquad (37)$$

where: $EALA_{P-F}^L$ = New (overall) road segment EALA reflecting no change in trucks carrying grain-legally loaded

$EALA^{O}_{P-F}$ = New (overall) road segment EALA reflecting net change in trucks carrying grain - overloaded

$\% \quad EALA^{L}_{P-F}$ = Percent change in (overall) EALA present to future for trucks carrying grain - legally loaded

$\% \quad EALA^{O}_{P-F}$ = Percent change in (overall) EALA present to future only for trucks carrying grain - overloaded

$\% \quad EALA^{L}_{B-F}$ = Percent change in (road segment) EALA for base case grain traffic to future (scenario and residual) traffic only - legally loaded trucks

$\% \quad EALA^{O}_{B-F}$ = Percent change in (road segment) EALA for base case grain traffic to future (scenario and residual) traffic only - overloaded trucks

$EALA_{p}$ = Present overall EALA on a road segment

$EALA^{L}_{S}$ = EALA for legally loaded trucks for scenario traffic

$EALA^{L}_{B}$ = EALA for legally loaded trucks for base case traffic

$EALA^{O}_{S}$ = EALA for overloaded trucks for scenario traffic

$EALA^{O}_{B}$ = EALA for overloaded trucks for base case traffic

G. Grain Subterminal Specifications

Specifications on the rated performance of machinery and associated costs for a modern grain subterminal facility were obtained from the Jacobson & Sons Construction Company of Bismarck, ND and used in this study. This information is presented below:

Component	Description/Specification/Rating	Total Cost
• Sitework	Site grading, roadways, spur trackage with switches, utilities, etc.	$ 385,000
• General Elevator and Structures	500,000 bu. capacity reinforced concrete elevator structure with machinery head house (Note: structures to include scale pits, driveway building and finished two story general office)	$1,600,000
• Storage Annex 1/	500,000 bu. capacity reinforced concrete storage annex with related conveying machinery	$ 900,000
• General Elevator Machinery	One - 10'0" x 80'0" x 60 Ton platform scale with 35'0" dumper section One - 10'0" x 70'0" semi-dumper platform with 60 Ton load cell scale Two - 10,000 BPH "Rec./Transfer" bucket elevators Two - 10,000 BPH gravity screeners One - 4 duct, urethane lined, electric roto flo distributor Two - 2,500 BPH uni-flo cylinder cleaners One - 10,000 BPH "utility" bucket elevator One - 25,000 BPH "shipping" bucket elevator One - 48,000 BPH bulk weigher shipping scale system One - auto-sampler at shipping spout Lot - hydraulic cylinder operated shipping and pit gate system Misc. - service manlift, air compressor with pipe and fittings, high bin monitors, bin spouting, etc.	$1,100,000

1/ The storage annex is included in the facility with a storage capacity of 1,000,000 bushels only.

Component	Description/Specification/Rating	Total Cost
● Special Equipment	100 HP bag filter dust collection system with dust pickups at rec. pits, cleaners and distributor (includes floor sweeps for housekeeping)	$ 85,000
● Electrical	Power entrance, motor wiring, lighting and control wiring	$ 140,000
	TOTAL COST	$3,310,000 or $4,210,000*

*(includes storage annex)